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# ACTA RADIOLOGICA

EDITA PER SOCIETATES RADIOLOGICAS DANICÆ,  
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VOL. V FASC. 2

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## ON THE EFFECT OF LIPJODOL ON THE MENINGES

by

*Adolf F. Lindblom, Med. Lic.*

Injection of lipjodol<sup>1</sup> in the bronchi, for example, does not generally produce any detectable clinical symptoms of irritation. Absorption takes place without reaction and during a fairly short space of time. The case is different with subdural injections.

In order to find out the effect of lipjodol on the meninges the author carried out experiments with subdural injections on 7 rabbits. The mode of procedure was as follows: The skull was trephined, with every aseptic precaution, immediately in front of the cerebellum by the help of a trephine or an armed probe after which about 1 cm<sup>3</sup> of lipjodol was injected subdurally. In some cases the needle was also introduced into the lateral ventricles where a certain amount of lipjodol was injected. The injections were done slowly and carefully. Immediately after the operation the rabbits were examined under X-rays in order to determine the exact position of the injected lipjodol. One rabbit died one day after the injection; the rest of them were killed at different times after the injection (2 days — 4 months). Repeated X-ray examinations were carried out during this time, including, in most cases, such of the detached brain and spinal cord.

The general condition of most of the animals was more or less affected during the next few days after the injection. They were

<sup>1</sup> Lipjodol is an organic combination of iodine and oil of white poppy. Free iodine can only be detected in lipjodol after combustion. The variety that has been used in the clinical cases as well as in the experiments on animals is: »Lipjodol Lafay», manufactured by Maison Leczinski, Paris.

distinctly unlively, had no inclination to take food and were generally sitting with head bent backwards and with ears along their bodies. These symptoms completely disappeared after one to two weeks, the condition afterwards remaining entirely unaffected, notwithstanding the continued presence of large quantities of lipjodol (as proved by X-rays).

As already mentioned, one rabbit died one day after the operation. The injection had been given between 1 and 2 p. m. The author examined the rabbit on the following day between 10 and 11 a. m. and at

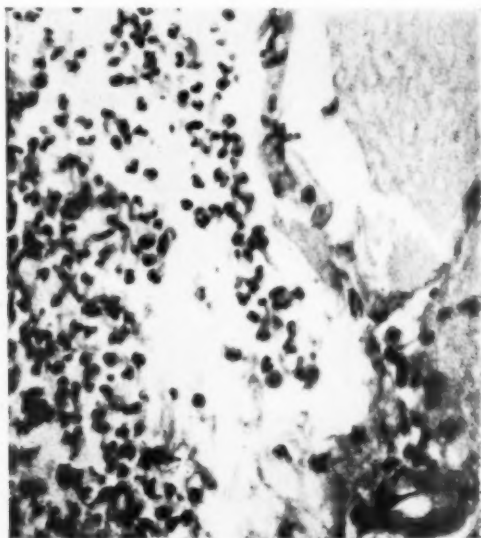


Fig. 1. Micro-photograph of leptomeningitis one day after subdural injection of about 1 cm<sup>3</sup> lipjodol (on rabbit). Most of the cells consist of leucocytes. The cerebral cortex is seen on the right.

that time its appearance was not different to that of the other animals (had no spasms). The same afternoon the rabbit was found dead in its cage in a position of opisthotonos. Death must have followed upon clonic spasms as everything in the cage had been kicked away. On section one found no injury to the brain; subdurally there were large quantities of lipjodol but no signs of haemorrhage.

Histological examination of brain and spinal cord reveals early signs of leptomeningitis already after one day. Scattered cell-infiltra-

tions, mostly leucocytes, are seen in the meninges (fig. 1). After two days this leptomeningitis has reached its full development. Wherever the X-ray examination or the p.m. section had shown the presence of lipjodol subdurally, leucocytes and puscells mixed with somewhat fewer lymphocytes were found in abundance in the meninges. After 2—3 weeks there are only single leucocytes, lymphocytes and plasma-cells. Two months after the injection no changes are to be seen any longer in the meninges in spite of the lipjodol still being present in quantities. Even after a lapse of 4 months there is still lipjodol present subdurally in the spinal cord without any histological changes.

It is impossible to decide whether similar changes are produced by injection of lipjodol into the ventricles as no such injection was done on animals that died or were killed prior to the 18th day and no changes were found in the ependyma of the ventricles on or after that day.

No bacteria were detected in histological preparations stained with methylene-blue. In preparations stained on fat (with sudan III) there appear here and there in the pia mater cells of otherwise normal appearance which have taken up lipjodol in the form of small drops. These drops, the smallest of which take up the stain very feebly, vary greatly in size. These pictures show that the pia is able to absorb the lipjodol. They are, however, scarce and do not show any existing inflammatory reaction in form of so called fatty granuloma. This circumstance would explain the slow absorption of subdurally injected lipjodol. As mentioned above, in the experiments carried out by the author, the lipjodol remained as long as 4 months after the injection; clinical experience also shows that lipjodol remains for a considerable time in the subdural space. Similar evidence may be obtained from preparations of the ependyma in those cases where the lipjodol has been injected into the ventricles.

*It is thus clear that lipjodol, injected subdurally into rabbits in comparatively large quantities, gives rise to acute leptomeningitis that soon subsides. In only one case out of seven has this meningitis had a fatal end. Histologically there is an abundance of cellinfiltrations in the meninges mainly consisting of leucocytes. Subsidence takes place after a few weeks after which no changes can be seen in spite of large quantities remaining in situ. The cells in the pia are able to absorb lipjodol but the process seems a very slow one.*

Since January 1925 subdural injections of lipjodol on man have, for diagnostic purpose, been carried out in the Medical division at the Umeå hospital. The senior physician has communicated to the author those clinical results of the investigations having a bearing on the subject in question. Brief reference will be made to these but, as not

yet concluded, what follows must only take the form of a preliminary communication.

The investigations include five cases. Three of these had tumour of the spinal cord (diagnosis confirmed at operation), one was a suspected tumour of the spinal cord and one a suspected tumour of the brain (the last two were not operated). In four of these cases the spinal fluid, prior to the injection, showed changes in the character of a reasonably increased cellcontent (up to 15 per  $\text{mm}^3$ ) and albumin, (NONNES weakly positive). *In one case the spinal fluid showed no changes before the injection.*

All the cases had 10–20  $\text{cm}^3$  of fluid removed from the lumbar canal prior to the injection there of 5–10  $\text{cm}^3$  lipjodol. All the cases reacted in identically the same way with pronounced meningeal symptoms (general malaise, temp. up to  $39^\circ \text{C}$ , vomiting, headache, marked stiffness of neck and LASÈGUE's test strongly positive). The symptoms were equally well marked whether the injected dose was 5 or 10  $\text{cm}^3$ . They started already on the first day but reached their intensity from the third to the sixth day. Lumbar puncture was performed during the height of symptoms in three cases when one found an increased cellcontent (500–1,000 cells per  $\text{mm}^3$ ) and NONNES and PANDY's tests weakly positive. The cells consisted exclusively of lymphocytes in all three cases and no micro-organisms were found. All symptoms had disappeared in fourteen days. In one case where lumbar puncture was done one month after the injection, the spinal fluid had the same appearance as before the injection (there seemed to have been recovery from the meningitis caused by the injection). While the meningeal symptoms lasted one also observed a recrudescence of the local condition.

These experiments and clinical observations do not fully elucidate the causation of meningitis. It cannot be put on the account of bacterial infection. The injections have been carried out under strict aseptic conditions and the lipjodol used has been sterilized. Staining for bacteria of the histological preparations and the lumbar fluid has given negative results. The explanation might have been a rapid liberation of iodine during the first days after the injection. There may also be the possibility of lipjodol containing some substance having an irritative effect on the meninges and being absorbed during the time immediately following upon the injection. It is worthy of special notice that the cell infiltrations of the meninges in the animal experiments were mostly made up of leucocytes while, on the other hand, in the clinical cases the increased cellcontent in the lumbar fluid consisted entirely of lymphocytes. The difference may possibly depend upon the relatively large amount of lipjodol injected into the rabbits; but

the reaction to similar agents is also probably different in man and rabbit.

These investigations have been carried out on the initiative of Professor FOLKE HENSCHEN to whom I beg to express my gratitude. I am indebted to the Senior Physician at Umeå Hospital Doctor MARTIN ODIN for the clinical data referred to above. My thanks are also due to the Chief Clinical Assistant of the X-ray Department at »Serafimerlasarettet», Doctor ARVID LUNDQUIST, for his valuable help in the X-ray examination of the animals.

### SUMMARY

Subdural injections of relatively large quantities of lipjodol into rabbits give rise to acute leptomeningitis, evidenced histologically by an extensive infiltration of cells (mainly leucocytes). It subsides in two or three weeks. In one case of seven it resulted in death. After the period mentioned above no histological changes remain, in spite of remaining large quantities of lipjodol. After intralumbar injection of lipjodol (5–10 cm<sup>3</sup>) in man, acute leptomeningitis develops with marked increase of cells in the lumbar fluid (exclusively lymphocytes). The meningeal symptoms have subsided within two weeks after the injection.

### ZUSAMMENFASSUNG

Subdurale Injektionen relativ grosser Mengen von Lipjodol bei Kaninchen veranlasst akute Leptomeningitis, die sich histologisch in einer ausgebreiteten Zellinfiltration (hauptsächlich Leukozyten) äussert, und nach zwei oder drei Wochen zurückgeht. Bei einem von sieben Fällen führte sie zum Tode. Nach der oben erwähnten Zeit bestehen keine histologischen Veränderungen fort, trotz zurückgebliebener grosser Mengen von Lipjodol. Nach intralumbaler Injektion von Lipjodol (5–10 ccm) beim Menschen, entwickelt sich akute Leptomeningitis mit ausgesprochener Vermehrung der Zellen in der Lumbalflüssigkeit (ausschliesslich Lymphozyten). Die meningealen Symptome verschwanden binnen zwei Wochen nach der Injektion.

### RÉSUMÉ

Des injections sous-durales de doses relativement massives de lipiodol chez le lapin donnent lieu à des phénomènes de leptoméningite aiguë, histologiquement démontrée par une infiltration étendue de cellules (nombreux leucocytes). Ces phénomènes s'atténuent au bout de deux ou trois semaines. Dans

un cas sur sept, la terminaison a été mortelle. Au bout de la période ci-dessus, on ne constate plus aucune modification histologique notable, en dépit de la persistance d'une quantité considérable de lipiodol. Après une injection intra-rachidienne de lipiodol chez l'homme (5—10 cc.), on a observé une leptoméningite aiguë avec prolifération cellulaire marquée dans le liquide céphalorachidien (exclusivement lymphocytes). Les signes méningés se sont atténués deux semaines après l'injection.



## RÖNTGENOLOGISCHE ANALYSE EINER SELTENEN MISSBILDUNG DES SCHLÄFENBEINS UND DIE TECHNIK IHRER UNTERSUCHUNG

VON

*Dr. Ernst G. Mayer*

(Tabulae VIII—IX)

Die Missbildungen des Schläfenbeins, es handelt sich da vorwiegend um kongenital angelegte Stenosen und Atresien des äusseren Gehörganges, sind durch die Fortschritte in der Oto-Röntgenologie der Untersuchung gut zugänglich geworden. Der Wert derselben liegt weniger auf klinischem als auf wissenschaftlichem Gebiet, da die Zahl der zur Sektion gelangenden Fälle gering ist. Die Röntgenstrahlen geben uns nun Gelegenheit zu einer weitgehenden Analyse intra vitam. Wenn auch die Ergebnisse derselben hinter denen der anatomischen Untersuchung zurückstehen, so besteht doch die Möglichkeit nachzuweisen, welche von den einzelnen Teilen, aus denen das Schläfenbein aufgebaut ist, vorwiegend an der Missbildung beteiligt sind. Da sich ausserdem auf diese Weise ein grosses Material sammeln lässt, so bekommen wir dadurch ein Bild von der Häufigkeit der einzelnen Formen. Ich habe in früheren Arbeiten eine Reihe kongenitaler Stenosen und Atresien zusammengestellt. Gemeinsam mit den bisher publizierten, anatomisch untersuchten Fällen lassen sich folgende Gruppen nach ihren Hauptmerkmalen unterscheiden:

1. Aplasie des Os tympanicum.
2. Hyperplasie des Processus styloideus mit und ohne Hypoplasie des Os tympanicum.
3. Hypoplasie und Verbildung des Os tympanicum mit und ohne Hyperplasie des Processus mastoideus oder Processus styloideus.
4. Hyperostose des Os tympanicum.

Der vorliegende Fall stellt nun eine völlig differente Form dar, die in keine dieser Gruppen hineinpasst.

Ehe wir zu seiner Besprechung gehen, ist es nötig Einiges über die Untersuchungsmethodik vor auszuschicken.



Das Schläfenbein wird in 3 Richtungen aufgenommen, und zwar:

1. nach SCHUELLER: der Zentralstrahl liegt in der senkrecht zur Deutschen Horizontalen (DH) durch beide äusseren Gehörgänge gelegten Ebene. Er bildet mit der DH einen Winkel von 35 Graden, dementsprechend mit der Sagittalebene einen solchen von 65 Graden und zielt auf den äusseren Gehörgang. Platte dem zu untersuchenden Ohr anliegend.

2. nach STENVERS: der Zentralstrahl liegt in einer Ebene, die senkrecht zur DH und unter 45 Grad zur Sagittalebene durch den Mittelpunkt der Verbindungslinie des äusseren Orbitalrandes und des äusseren Gehörganges der zu untersuchenden Seite geht. Er zielt auf diesen Punkt und bildet mit der DH einen nach hinten unten offenen Winkel von 10—15 Graden. Platte parallel der Tischebene, Patient befindet sich in Bauchlage, den Kopf um 45 Grad gedreht, sodass das zu untersuchende Ohr dem Tisch, beziehungsweise der Platte genähert wird.

3. nach MAYER: der Zentralstrahl liegt in einer Ebene, die senkrecht zur DH durch den Warzenfortsatz der zu untersuchenden Seite und den äusseren Orbitalwinkel der kontralateralen Seite geht. Er zielt, mit der DH einen Winkel von ca. 45 Graden bildend, auf den zu untersuchenden Warzenfortsatz. Patient in Rückenlage, den Kopf um 45 Grad nach der kranken Seite gedreht, Platte dem Ohr anliegend.

Die Abbildungen A 1—3 zeigen je eine Normalaufnahme. Bei der Ersten (SCHUELLER) überblicken wir das Mastoid, das Os tympanicum, das Tegmen und den Sinus. Bei der Zweiten (STENVERS) die ganze Pyramide und das Labyrinth, bei der Dritten (MAYER) Gehörgang und Mittelohrräume. Wir haben somit die Möglichkeit alle wesentlichen Details zur Darstellung zu bringen.

Der vorliegende Fall betrifft ein 13jähriges Mädchen, das mit folgenden Angaben zur Röntgenuntersuchung an das Institut gewiesen wurde: Schwerhörigkeit durch Störung der Schalleitung, rechte Ohrmuschel in geringem Grad missbildet, Gehörgang von oben her eingengt, Trommelfell sichtbar, Manubrium mallei verplumpt, leichte Parese vorwiegend des 3. Facialisastes.

Röntgenbefund: Pars mastoidea, Pyramide und Os tympanicum sind von normaler Grösse. Der Processus styloideus ist kurz, plump und etwas nach lateral verschoben. Die Pars mastoidea ist spongiös und lässt keine Zellen erkennen. Das Antrum ist weit, unregelmässig, jedoch scharf begrenzt. Der Aditus ist wesentlich weiter als auf der gesunden (normalen) Seite. Der Attik (Recessus epitympanicus) ist nicht erkennbar, während er auf der gesunden Seite sehr geräumig ist. In der Gegend des ovalen Fensters ist eine unregel-



mässige, exostosenartige Sklerosainsel erkennbar, die vermutlich den verbildeten und stark verplumpten Gehörknöchelchen entspricht. Die Paukenhöhle zeigt in der Draufsicht annähernd normale Dimensionen. Die Bogengänge sind schmal, Schnecke und innerer Gehörgang lassen keine Veränderungen erkennen. Der äussere Gehörgang und anscheinend auch der ventrale Teil der Paukenhöhle sind durch mächtige Hyperostose ihres Daches von oben her eingeengt.

Zusammenfassend ergibt sich demnach:

1. Heterotopie des Processus styloideus.
2. Hochgradige Hyperostose des vorderen Teiles des Tegmen tympani und des Daches der Kiefergelenkspfanne und des Gehörganges.
3. Sklerosainsel in der Gegend des ovalen Fensters, wahrscheinlich den verbildeten Gehörknöchelchen entsprechend.

Die Heterotopie des Processus styloideus wäre vielleicht imstande die Facialisparesie zu erklären. Die Störung der Schalleitung erklärt sich aus der klinisch am Hammer erkennbaren, röntgenologisch auch für die übrigen Gehörknöchelchen wahrscheinlich gemachten Missbildung derselben, die Einengung des Gehörganges durch die Verdickung des ventralen Teiles des Paukenhöhlendaches und der oberen Gehörgangswand. Dieser Teil des Tegmens entsteht entwicklungsgeschichtlich aus einer fibrösen Platte, die sich ventral an den Processus perioticus Gradenigo, der das übrige Tegmen bildet, anschliesst.

Dieser Fall möge als Beispiel dafür dienen, dass wir imstande sind Schläfenbeinmissbildungen intra vitam weitgehend röntgenologisch zu analysieren und dadurch den klinischen Befund in wesentlichen Punkten zu ergänzen.

*Beschreibung der einzelnen Abbildungen:* Die Abbildungen unter A. sind normale Bilder, die unter B. die der Missbildung. Die Skizzen sind Pausen der Röntgenbilder und decken sich daher mit denselben vollkommen. Zur leichteren Orientierung sind auf Abbildungen und Skizzen korrespondierende Fadenkreuze eingezeichnet.

A. 1. Aufnahme nach SCHUELLER. Die beiden Linien schneiden sich an der Stelle, wo innerer und äusserer Gehörgang über einander projiziert sind. Im rechten unteren Quadranten sehen wir das von der Pyramidenspitze überdeckte Kiefergelenk. Links der Vertikalen die geschwungene Linie, die die rückwärtige Kante der Pyramide darstellt und den Verlauf des Sinus kennzeichnet. Vom linken oberen Quadranten zieht durch den rechten oberen herunter zum Kiefergelenk die obere Pyramidenkante. In der Verlängerung der hinteren Pyramidenkante sehen wir im linken unteren Quadranten die Spitze des Warzenfortsatzes. Rechts vor derselben, durch die Vertikale zum Teil geschnitten, liegt das Os tympanicum.

A

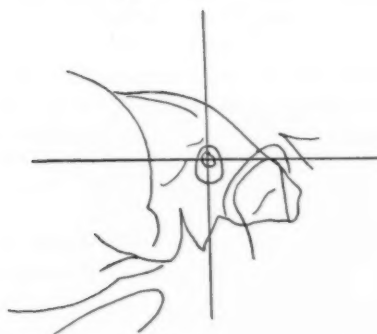


Fig. A 1.

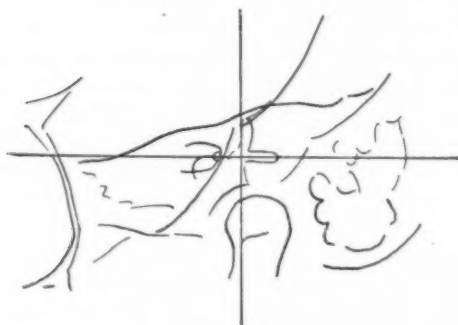


Fig. A 2.

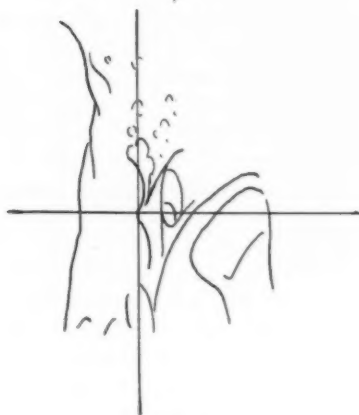


Fig. A 3.

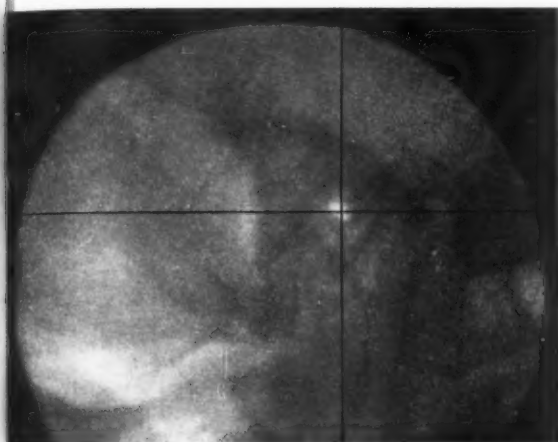


Fig. A 1.



Fig. A 3.

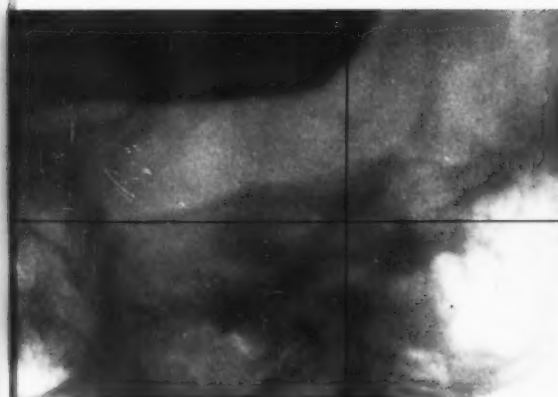


Fig. A 2.



B. 1. zeigt analoge Verhältnisse, nur ist hier das Kiefergelenk nicht gut erkennbar und ausserdem sehen wir im rechten oberen Quadranten in der Gegend der oberen Pyramidenkante eine mächtige Verdickung (in der Skizze schraffiert).

A. 2. Aufnahme nach STENVERS. Die Horizontale geht durch die ganze Länge der Pyramide, und zwar liegt die Pars mastoidea im Bilde rechts, die Spitze links. Ganz links sind die Konturen der Orbita erkennbar. Die obere Pyramidenkante verläuft schräg von rechts oben nach links unten durch die beiden oberen Quadranten. Dort wo sich Horizontale und Vertikale schneiden erkennen wir die zarte Aufhellung, die durch das Vestibulum bedingt ist. Von ihr aus lässt sich nach oben der sagittale Bogengang, nach rechts genau horizontal der seitliche verfolgen. Links vom Kreuzungspunkt sehen wir, von der Horizontalen durchschnitten, eine ovale Aufhellung, die dem inneren Gehörgang entspricht. Die Vertikale schneidet in ihrem unteren Anteil das Kiefergelenk.

B. 2. zeigt ähnliche Verhältnisse, nur ist die Stellung der Pyramide zum Kreuz etwas verschoben und zwar derart, dass die Pyramidenspitze etwas höher, die Pars mastoidea etwas tiefer zu liegen kommt. Doch liegt auch hier der Kreuzungspunkt der Linien über dem Vestibulum. Im rechten unteren Quadranten sehen wir eine scharfbegrenzte, intensive Verdichtung (in der Skizze schraffiert), die gleiche, welche wir schon in der Aufnahme nach SCHUELLER sahen und die wir infolgedessen jetzt durch Kombination beider Aufnahmen genau lokalisieren können. Sie entspricht dem ventralen Teil des Tegmen tympani, dem rückwärtigen Teil des Daches der Kiefergelenkspfanne und dem inneren Teil des Daches des äusseren Gehörganges.

A. 3. Aufnahme nach MAYER. Die Pyramide liegt so, dass die Basis in den beiden oberen Quadranten zur Darstellung kommt, während die Spitze nach unten weist und zum grössten Teil im linken unteren Quadranten liegt. Im rechten unteren Quadranten sehen wir, zum Teil von der Horizontalen noch geschnitten, das Kiefergelenk. Die geschwungene Linie, die links von demselben fast bis an die Vertikale heranreicht, entspricht der vorderen Begrenzung der Pyramide. Durch die beiden rechten Quadranten zieht schräg von rechts nach links die rückwärtige Begrenzungslinie. Hauptsächlich im rechten oberen Anteil sind die zarten, kleinfleckigen Aufhellungen der Cellulae mastoideae zu erkennen. In ihrem Bereiche liegt gerade über dem Schnittpunkt der Linien eine intensivere, gegen die Umgebung nicht scharf abgrenzbare Aufhellung, die durch das Antrum mastoideum hervorgerufen ist. Diese setzt sich nach unten in einen schmalen Streifen fort, der genau beim

D

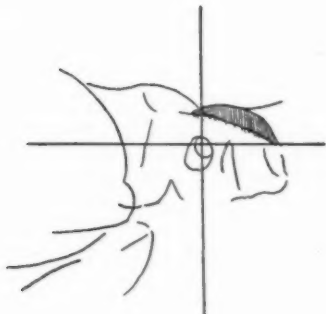


Fig. B 1.

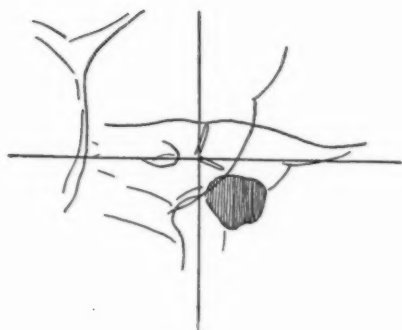


Fig. B 2.

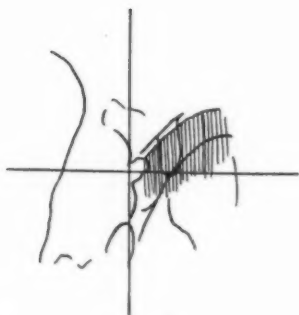


Fig. B 3.

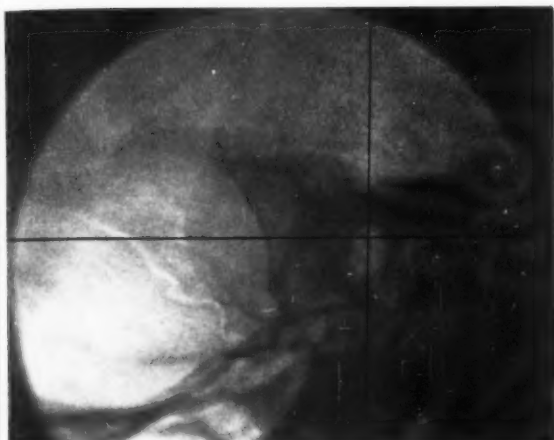


Fig. B 1.

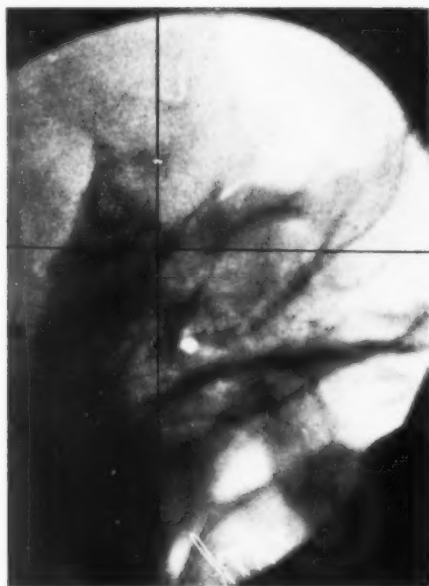


Fig. B 3.

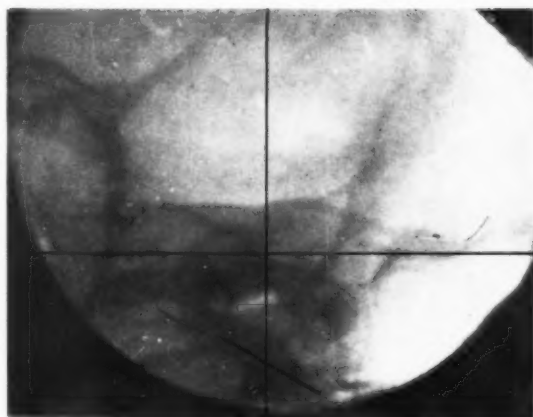


Fig. B 2.





Kreuzungspunkt endet und dem Aditus ad Antrum entspricht. Rechts davon sehen wir, schräg von rechts oben nach links unten verlaufend, den äusseren Gehörgang, dessen vordere Wand mit der vorderen Begrenzung der Pyramide zusammenfällt, während seine hintere Wand in dem dichten Schatten liegt, der den Aditus rechterseits begleitet. Dieser wird nicht nur von der hinteren Gehörgangswand, sondern auch vom vorderen Kontur des Warzenfortsatzes und dem äusseren Anteil des Os tympanicum gebildet. Rechts von diesem Schatten ist im Bereiche des Gehörganges eine ziemlich starke Aufhellung zu sehen, die durch den Kuppelraum der Paukenhöhle hervorgerufen ist. Der dichte Schatten, der fast zur Gänze links von der Vertikalen liegt und nach vorne durch zwei Bogen begrenzt ist, die von dieser eben geschnitten werden, ist der kompakte Labyrinthknochen.

B. 3. Das Fadenkreuz liegt hier ebenso wie in der Normalaufnahme. Der Gehörgang und auch das Kiefergelenk sind durch den verdickten Teil der Schädelbasis grösstenteils verdeckt. Im Gehörgang sieht man einen von seiner hinteren Wand ausgehenden, nach unten bis an die Horizontale reichenden zapfenförmigen Schatten, den verplumpten und verschobenen Processus styloideus. Der kompakte Labyrinthknochen ist von der Kreuzungsstelle nach oben zu nicht in einem regelmässigen Bogen begrenzt, wir sehen vielmehr dort eine unregelmässige Verdichtung, die vermutlich den verbildeten Gehörknöchelchen entspricht.

### ZUSAMMENFASSUNG

Zur erschöpfenden Untersuchung des Schläfenbeins sind 3 Aufnahmen notwendig und zwar:

- 1) nach SCHUELLER,
- 2) nach STENVERS,
- 3) nach MAYER,

Im vorliegenden Falle ergibt die Röntgenuntersuchung:

- 1) Heterotopie des Processus styloideus,
- 2) Hochgradige Hyperostose des vorderen Teiles des Tegmen tympani und des Daches der Kiefergelenkspfanne,
- 3) Sklerosainsel in der Gegend des ovalen Fensters wahrscheinlich den verbildeten Gehörknöchelchen entsprechend.

<sup>1</sup> Fortschritte auf dem Gebiete der Röntgenstrahlen B. XXXII—XXXIII.

## SUMMARY

For the exhaustive investigation of the temporal bone three takings are necessary, namely:

- 1) according to SCHUELLER,
- 2) according to STENVERS,
- 3) according to MAYER.

In the case before us the roentgen examination yields the following results:

- 1) Heterotopy of Processus styloideus.
- 2) Excessive hypertrophy of bone in the anterior part of Tegmen tympani and of the roof of the temporo-maxillary articulation pan.
- 3) Sclerosis islands in the region of the fenestra ovalis, probably corresponding to the malformed auditory ossicle.

## RÉSUMÉ

Pour faire un examen complet du temporal, il est nécessaire de prendre trois plaques, notamment:

- 1) d'après SCHUELLER,
- 2) d'après STENVERS et
- 3) d'après MAYER.

Dans le cas actuel, l'examen radiographique permet de constater:

- 1) Une hétérotopie de l'apophyse styloïde,
- 2) une hyperostose marquée de la partie antérieure du tegmen tympani et du toit de l'articulation temporo-maxillaire.
- 3) des îlots de sclérose dans la région de la fenêtre ovale, correspondant vraisemblablement à une déformation pathologique des osselets.



## GENERAL LIGHT TREATMENT IN SURGICAL TUBERCULOSIS

by

*Ole Chievitz*

Introductory Address at the 4th Meeting of the Northern Association for  
Medical Radiology in Helsingfors, September 1st and 2nd 1925

Before this audience, there is no necessity for me to insist on the very great value of the irradiation therapy in surgical tuberculosis. At the same time, there is not one among us, of course, who believes it to be the one and saving treatment for that disease.

My intention, in addressing you to-day, is merely to show you, in a brief review, how, from our experience at the *Finsen Institute*, we look at the indications for its application.

As regards the technique, we use chiefly — I might say: almost exclusively — the carbon-arc light. This is given the patient three times a week, for two and a half hours at each sitting, in the form of a full light-bath, on the naked body, with any possible dressings or bandages removed. As Dr. REYN, the chief physician of the Institute, will explain to you more fully, it is by no means indifferent what type of lamp is used. From smaller hospitals, where a light-bath equipment has been installed, complaints have not infrequently been forthcoming to the effect that the patients did not become »pigmented»; and when the matter was looked into, the trouble was invariably found to lie with some grave fundamental fault or other, either in the design of the plant or in the choice of some of its component parts.

The light-bath is, of course, only one side of the treatment of the tuberculous case. It would be best, of course, to combine with it a complete »sanatorium and hospital treatment». With our in-patients we do this as far as possible; keeping them in bed if necessary — and that as much of the time as possible *in the open*

air; and employing at the same time, in each case, the most appropriate bandaging, corrective and pain-reducing stretching appliances, etc. But unfortunately it is only a limited number of our patients whom we are able to admit in this way. The majority must remain outdoor cases, and most of these come from poor homes. In most of these cases we nevertheless obtain good results; but in where there is no seeming progress to be noticed, a change for the better will often be seen to occur if the patient is hospitalised and gets sufficient nourishment and care.

All cases of *spondylitis* and of *affections of the lower limbs* are, as far as possible, hospitalised and treated as bed cases, with the exception of very small children suffering from *Ostitis metatarsi*. These are *carried or wheeled* to the Institute for treatment, and their mothers are cautioned most earnestly to see to it that the child is not allowed to stand on its legs or walk. Still, in spite of this principle, it cannot be avoided, of course, that we are sometimes obliged to take a *spondylitis* patient as an ambulant case, because we have no bed vacant.

In the matter of *diagnosis* I hold that we can never be strict enough. There will, of course, always be a certain number of cases in which the diagnosis: tuberculosis may be open to doubt. Such cases can very well be treated with light-baths, of course; only, we must not include them in the statistics. Little by little, as our knowledge and experience becomes more extensive, we are forced to revise our old results, and often we have to eliminate cases, because we now discover that they were not due to tuberculosis at all. This is very much the case with affections in the elbow-joint.

In tuberculosis of the bones and joints, radiography is, of course, an invaluable aid to diagnostication; but it can never be said strongly enough that the pictures must be *good pictures*. Poor pictures are worse than nothing; and in that respect the part of the body in the radiographing of which the gravest and most frequent faults are committed is the wrist. One gets some poor plates of that locality, and diagnosticates: tuberculosis; then, afterwards, if one gets some good pictures of the same locality, the affection turns out to be a traumatic one, with separations, etc.

If one continues to take X-ray pictures, from time to time, during the treatment of a 'fresh' case which, clinically, is improving very nicely, one will often be astonished to find the plates indicating something rather in the nature of an 'aggravation', by the fact that the destructions now gradually begin to show up. If this happens, it is simply a case of not getting scared, however; and of basing one's judgment on the clinical picture as a whole.

Anyhow, I believe that the skiagraph sometimes »defines too finely», in the sense that the structures in a bone which has been the seat of a protracted inflammation will show an irregular design, owing to some irregular distribution of the calcareous matter, even long after this inflammation has been healed, while on operating the bone will be found to be normal and solid. A case of this kind is the following. The patient was a young man, who had a small fistula in the sinus tarsi. The X-ray picture showed destruction of the calcaneus. As there continued to be secretion, intermittently, by drops, I chiselled open the bone, but found it to be sound and normal, except for just the slightest amount of granular tissue, close to the fistula.

Tuberculin is used as a means of diagnosis chiefly in connection with PIRQUET's test; as a subcutaneous injection I have not had very much use out of it, especially not as regards focal reactions.

If, now, we speak about the *effects* of the light bath, we are bound to admit our almost complete ignorance of their true character. It is hardly a case of any really »specific», anti-tubercular effect, of course; rather, perhaps, is it the various »defensive» elements of the patient's system that becomes stimulated. The most strikingly noticeable effect observed is *the enormous improvement in the general condition*. We see patients who are suffering from the most severe cases of fistulous coxitis or spondylitis lie for years continuing to look healthy and without getting amyloidosis; and we have even seen cases where amyloidosis had set in before the treatment commenced, and where it subsequently disappeared. Some of the most gratifying cases to treat are precisely those in which the general condition is very much run down, at the same time as they present numerous, not too grave tuberculous foci.

As regards the more remote effect of the light-bath on the tuberculous focus, I am inclined to believe that the treatment increases the spontaneous tendency of the tuberculous inflammation to become encapsulated in the fibrous connective tissue; and in many cases the infection is in this manner entirely overcome, while, in other cases, it will at least remain temporarily quiescent in this encapsulated state, perhaps with just a slightly suppurating fistula. I believe this view of the matter to have a certain importance with regard to the treatment, because, with the focus securely encapsulated, a surgical intervention for the purpose of getting rid of the last, obstinate remnant of infection will not be very risky seeing that this intervention involves only operation in healthy tissue, capable of reaction, outside the focus, and the removal of such tissues; or else — if we attack the focus itself, as in the case of isolated abscesses — there will still be the solid membrane of connective tissue,

capable of resistance, left after the tuberculous granulations have been scraped off. As an absolute contrast to these cases we have, of course, those — fortunately much rarer — malignant ones, which show incessant propagation without any protecting barrier; and in those I regard an operation in the diseased tissue itself, with a view to its possible removal by resection or some such proceeding, to be an absolute mistake. Here the indication is for amputation in healthy tissue at a good and sufficient distance from the diseased area.

Similarly, I believe it is often inadvisable, in tuberculosis, to operate in the very early stages. It is better by means of light-bath treatment and rest to give the affection time to become encapsuled; but when this has been attained an operation may in many cases be indicated, as the best means of shortening and terminating the process. This will be the case, for instance, wherever a sequestrum is keeping the secretion alive. I am perfectly willing to admit that the resorption of a good many sequestra, and the closing of a good many fistulæ, can be attained by year-long conservative treatment; but I do not see, in that circumstance, any reason for not getting rid of them by surgical removal in cases which lend themselves to that form of intervention, when by that means the process can, without any very great risk, be shortened by many months, if not by years.

Concerning the conditions of immunisation, in tuberculosis, we know very little, of course. In a purely clinical way we can show that no absolute immunisation results from the light-bath treatment, because it is by no means rare to see new foci disclose themselves after some time. We are here touching on a point to which, generally, too little attention is paid; namely, the consideration of *time* as a factor in this disease. Surgical tuberculosis is a decidedly chronic disease. It can resist for decades, and similarly any kind of conservative treatment will of necessity take a very long time, — in fact, much longer than most are inclined to believe. It is for this reason that the operative treatment will always be justified in cases where its employment can help us to shorten the process of the disease, even if, in some instances, this object has to be attained at the cost of more or less diminishing the mobility of a diseased joint. I am quite aware that the conservation of this mobility has often — and, in my opinion, somewhat uncritically — been pointed to as one of the chief advantages of the light-treatment, and I would be among the very first to acknowledge the value of this advantage; but the first condition of a patient's having any joy of being able to move some particular joint is certainly that its normal use should not cause him continual pain; and this is where the treatment not



infrequently fails, as I shall come back to in a moment, when speaking of the knee-joint. But whatever the method of treatment, an essential point is that the function of the neighbouring joints should be preserved normal.

An important factor in governing our attitude to the indications is *the age of the patient*. In the first place, it cannot be sufficiently emphasized how much more benign the course of the tuberculous process is in children; and in the second place, the duration of the treatment does not matter so much in the case of the child, especially as it will often be possible to proceed with its teaching while the cure is going on. With children I am extremely conservative, and for several years I have not undertaken a single operation on a child, beyond évidements and the emptying of abscesses.

To speak, now, of the special forms of the disease, the largest group among these is formed by the cases of *spondylitis*. This, of course, is a serious affection, with a mortality percentage of about 30 per cent., and one in which a conservative treatment is practically the only one that can be thought of. What determines the course of this kind of cases almost more than anything else is whether there is a formation of fistulæ or not.

Rest in bed forms the most important part of the treatment. If there are pains even when the patient is lying down quietly, we use immobilisation in plaster-of-Paris bed for a year or so, combined with light-bath treatment; and if the latter cannot be procured on the spot I consider it better that the patient should remain in bed and be without it, rather than to have him seek it as an ambulant.

If abscesses or small fistulæ form at this early stage, they will have a great tendency to heal under the light-treatment. With patients who come in for this treatment only at a later stage, when the formation of fistulæ has been going on for years, the matter is entirely different. Cases of that kind put the treatment to the hardest possible test. Their general condition can be bettered and the secretion reduced, but a complete cure is very exceptional. Still, we have had a certain number of these cases, in which the healing was effected after year-long treatment, and among those there were even a few which, from the stress of circumstances, we had only been able to treat as ambulant cases.

One of the most serious features in connection with spondylitis is, of course, the kyphosis which is apt to result from it, especially in children. On this subject I have already in another place formulated some theoretical considerations, which I shall not reiterate here. As regards the treatment, I wish to point to the fine results obtained

by WALDENSTRÖM; and in speaking of these I may refer also, quite briefly, to »Albee's operation». My own experience with this form of intervention is slight; for, as a matter of fact, most of the cases of surgical tuberculosis with which I have had to do were either too promising, or else too bad, to suggest the advisability of this operation. I believe, however, that, if resorted to, it should certainly be followed by a much more prolonged rest in bed than is usually the case; because, as far as I can judge from my experience with bone transplantations, the transplanted section, on which the whole of the pressure will eventually come to rest, is weakest and most brittle about six or nine months after the operation. When this operation is used, as by WALDENSTRÖM, more as a corrective measure, the case is different.

One often wonders how relatively often the spondylitis runs its course without the occurrence of any morbid phenomena, until the symptoms finally manifest themselves in the form of such attending complications as, for instance, gravitation abscesses or paresis.

One complication that has to be paid particular attention to, in connection with the light-bath treatment, is the absence of sensibility in the cases where there is paresis. If this is not remembered, burns of the skin may result; because the patient, owing to this lack of cutaneous sensation, fails to react to a possible too excessive heat.

To clinch the matter once more: in my opinion, *bed in connection with light-baths is the sovereign treatment for spondylitis.*

In going over, now, to speak about *coxitis*, I wish to begin by saying a few words about the diagnosis of that disease. In the majority of cases the anamnesis and the X-ray picture will, of course, combine to make it a perfectly safe conclusion that we have to do with a tuberculous affection of the hip; but particularly in the case of young individuals the diagnosis can often be difficult. In many cases a good X-ray picture will dispel the incertitude, for instance by showing a coxa vara, or an epiphyseolysis, and, most of all, where the case is in reality one of LEGG-CALVÉ-PERTHES disease, — an affection concerning which I need not go into any greater details in speaking before this audience, but of which you all know that most of the cases were formerly put down in the statistics under the heading: Tuberculosis, thereby causing the percentage of cures in that disease to appear higher than warranted by the actual facts. We also meet, especially in children, not a few cases in which the diagnosis must remain doubtful. Clinically, these cases resemble mild cases of *coxitis*; skiagraphically, there are no changes to be



seen. If PIRQUET's reaction proves positive I treat them as tuberculous, with rest in bed and light-baths. As a rule the symptoms disappear in very short time, the mobility becomes normal, and there is no relapse; — it is hardly a question of tuberculosis.

In cases of tuberculous coxitis we prescribe rest in bed and light-baths; if there are pains we make extension, and likewise in order to correct contracteurs, if there are any such.

To surgical intervention I am, in this kind of cases, extremely reluctant, especially if the patient is a child. But also in the case of adults I am averse to it, and most so because the operation is, in so very many instances, followed by the formation of fistulæ and the occurrence of tuberculosis in the soft tissue, owing to the failure of our present technique to indicate any means guaranteeing the absolute and complete removal of all the diseased tissue, and because these fistulæ often, after resection, prove surprisingly hard to get rid of, even by light-treatment.

During the treatment there will sometimes be a formation of abscesses and small fistulæ; but they generally close, and in many cases we obtain a cure, with the joint ankylosed in good position; but it takes years. With cases that only come in for treatment when the disease has already been progressing for years, with extensive fistulation and abscess formation, the situation is much more unfavorable; and in such cases to delay the exitus for a great length of time is often all we can do.

In treating *tuberculosis of the knee-joint* I make a sharp distinction between adults and children. For the latter, the treatment is exclusively conservative, with light-baths and rest in bed, often for years. In the case of adults, on the other hand, I am very much inclined to recommend resection. In cases where there is extensive osseous destruction, with more or less complete cessation of the mobility, it is easy to come to this decision; but experience has taught me that also in cases of less extensive fungus formation, with mobility still fairly unimpaired, and in which the chief complaint is of pains when walking on rough and uneven roads, operation will be to the best advantage of the patient. His knee will be stiff, to be sure; but in a few months he will be able to walk without pain, and he will be well satisfied with the change. I base this statement on my after-examination of a very great number of cases. On the other hand, I have, time and again, treated knee-cases of this kind for any length of time with bed and light-baths; the affection has to all appearances become quiescent, but as soon as the patient began to walk about again, the trouble would return.

The difference between the hip- and the knee-joint, with respect to operation, is that, in the case of the knee, the operation is a safe and relatively harmless one, by which the whole of the diseased tissue is removed, and in which there, therefore, hardly ever is any formation of fistulæ afterwards.

*Tuberculosis in the ankle-joint* is of considerably less frequent occurrence than the affections of which I have been speaking in the foregoing, and my experience regarding it is, consequently, less extensive. We have treated a number of cases of this kind with rest in bed and light-baths, and even in cases where there was fistulation and formation of abscesses we have obtained excellent results, in some instances by additional resort to energetic évidement and removal of sequestra. In older cases the morbid process sometimes shows a tendency to refuse to keep within bounds, and when this is seen to be the case I believe that an amputation on the crus should be performed at once, rather than to let the patient's forces be wasted through a long spell of conservative treatment which would not bring about the intended result anyhow.

*Tuberculous ostitis* in the tarsal bones, and more particularly in the calcaneus, can be made to disappear by light-bath treatment, especially in children, but it requires long time. The treatment can be considerably shortened, however, by excochleation of the focus, followed by light-treatment.

Of this affection as it utters itself in the small tubular bones of the foot, I shall speak when I come to deal with the disease in the corresponding bones of the hand.

Speaking, now, of the affections in the upper extremities, I must say that as regards *the shoulder-joint* our material is not particularly large. It is my impression that in this locality the disease is rather refractory to light-treatment. In spite of the immobilisation it often takes long time before the patient is free from pain, and the terminated treatment nearly always leaves him with only a slight amount of mobility in the joint.

As regards the affection in *the elbow* we shall have to revise the percentage hitherto set up for the cures by conservative treatment; for there is no doubt but that a number of these cases are not tuberculosis, but that many of them are in reality cases of the affection — which has been dealt with in a work by Dr. PANNER, among others — which shows itself, clinically, in restricted function, and skiagraphically in rarefactions in the eminentia capitata humeri,

increasing to defect in that locality. As far as I can see, about 20 per cent. of the elbow cases figuring on our records under the heading: tuberculosis (and formerly also treated as such) belong to this category.

Cases of tuberculous arthritis we treat by immobilisation by means of splint and sling, and by light-baths. The results are satisfactory, and when the osseous destruction is not too far advanced we often obtain a fair amount of mobility.

Also from among the *affections of the wrist* we have of late years been able, thanks to X-ray photography, to differentiate a large group of cases that had hitherto incorrectly been treated as tuberculous. It includes partly those in which we see the os lunatum compressed and somewhat irregular both in form and structure, and partly those in which small roundish rarefactions are to be seen, most frequently in the os lunatum, but also not infrequently in the os naviculare.

With respect to no other joint am I so convinced of the superiority of light-treatment as precisely with respect to arthritis manus tuberculosa, and that irrespectively of the patient's age and whatever the form of the affection. I feel hardly ever tempted to operate, beyond the opening of abscesses and a slight évitement of some fistula that shows itself too stubborn. In nearly all our cases of this kind we have succeeded in reducing the process to a state of quiescence, even in the case of very old people with fistulæ. Of course, the mobility at the wrist itself will often be lost, especially if there has been any too considerable amount of osseous destruction; but in the cases that are only slightly milder the mobility will be good, and the fingers, notably, will remain movable and strong, something which often fails to be the case after an operative intervention, as after-examinations have shown me.

It is true that the treatment takes a long time, — about a year; but it will take as long before the hand gets fairly serviceable after an operation, too. We immobilise the wrist itself by means of a volar splint which leaves the fingers free, and let the arm rest in a «mitella».

Similar good results are obtained, by light-treatment alone, in the cases of *ostitis in the small tubular bones of the hand and foot* (spina ventosa) which are so frequent in children. I venture to count, in cases of this kind, with a percentage of cures very close up to 100 per cent., and I would very much advice against operation.

On the other hand, it seems to me that *tuberculosis of the synovial membranes* is often very refractory to light-treatment.

From all that I have said in the foregoing I trust it will be clearly understood that with me it is not a question of holding up the actino-treatment as the sovereign remedy in surgical tuberculosis, as opposed to surgical intervention. On the contrary, I believe there is room for both methods, in such a way that in each individual case either one or the other is employed, or a combination of them both, according as our experience has taught us that it will be for the greatest benefit of the patients themselves.

### SUMMARY

The indications for the treatment of surgical tuberculosis at the Finsen Institute in Copenhagen are here passed in review. For children it is predominantly conservative, combined with a universal light bath. For adults the same largely holds good, but there is a tendency to advocate rapid resection in tuberculosis of the knee.

### ZUSAMMENFASSUNG

Der Artikel gibt eine Übersicht über die im Finseninstitut zu Kopenhagen eingehaltenen Indikationen für die Therapie der chirurgischen Tuberculose. Für Kinder ist die Behandlung recht überwiegend konservativ, kombiniert mit allgemeinem Lichtbad. Für Erwachsene gilt zum grossen Teil dasselbe, doch ist man hier bei Knietuberculose geneigt bald zur Resektion zu schreiten.

### RÉSUMÉ

L'auteur donne un aperçu général des indications thérapeutiques dans la tuberculose chirurgicale, à l'institut Finsen, à Copenhague. Chez l'enfant, le traitement est surtout conservateur; on le combine avec des bains généraux de lumière. Il en est à peu près de même chez l'adulte; toutefois, dans la tuberculose du genou, on recourt volontiers à une résection précoce.



## SOME EXPERIENCES IN CONNECTION WITH LIGHT-TREATMENT IN CASES OF SURGICAL TUBERCULOSIS

by

*V. Malmström*

Introductory Address at the 4th Meeting of the Northern Association for Medical Radiology in Helsingfors, September 1st and 2nd 1925

Additional evidence, beyond that which has already been adduced, of the value of light in the treatment of so-called surgical tuberculosis is hardly necessary. The pioneers of modern heliotherapeutics — BONNET, OLLIER and PONCET — were surgeons and employed sun-treatment with success for tuberculous articular diseases. The wealth of experiences collected and published since that time by FINSEN, BERNHARD, ROLLIER, REYN, ERNST, VULPIUS, BARDENHEUER, MALGAT and many others leave little room for doubt that light-treatment is a valuable addition to the arsenal of remedies in the science of healing even if, in some quarters, enthusiasm has led to some overvaluation of the method.

In Sweden Dr SVEN JOHANSSON, particularly, has for many years been interested in the light-treatment of surgical tuberculosis. As far back as 1914 he could point to encouraging results. In an important work published in 1924 entitled »Bidrag till kännedomen om ben- och ledtuberkulosen under barnaåldern»<sup>1</sup> (A contribution to the study of tuberculosis of the bones and joints in childhood) he makes a comparison between the cure results in light-treated and non-light-treated cases and summarizes his impressions as follows: »Even after the most extremely critical examination it seems undeniable that the general light-treatment employed supportingly has helped to improve results both as regards mortality and time of healing.»

From the beginning of 1914 I have employed light-treatment at the Högbo Consumption Hospital for both internal and external tuberculosis. The hospital is primarily intended for the care of tuberculosis of the lungs and larynx but the current regulations provide

<sup>1</sup> Svenska Läkarsällskapets Handlingar. Bd 50. H. 2.

that a small number of cases of external tuberculosis shall be received for general treatment. This to explain why I came to deal with surgical tuberculosis though lacking technical surgical knowledge. In the treatment of the surgical cases, however, I have enjoyed the advantage of profitable and intimate co-operation with the surgeons at the Falun hospital whence most of the cases have been transferred to us.

Besides the general sanatorium cure, on the same lines as that for consumptives, and besides the light-treatment, orthopaedic and surgical methods of treatment have been employed in cases where the surgeon has deemed them suitable. With the aid of the X-ray specialist at the Falun hospital, X-ray treatment has also been employed in some cases. Polyclinical light-treatment alone has been exceptionally employed.

I will now describe the technique employed at our hospital and endeavour to make clear the results attained by this (as a rule) combined treatment and finally discuss briefly the indications of the treatment.

### Method

The light-sources have been the sun, arc-lamps and quartz-lamps.

The sun baths are taken on special sun-bath balconies or out in the wood. On the first day of treatment the nether half of the body is exposed to sunlight for 15 minutes. Afterwards the whole body is sunbathed — 2nd time 15 minutes, 3rd time 30 minutes, 4th time 45 minutes, 5th and following times 60 minutes; occasionally I have gone up to 2 hours. The sun-baths are taken daily, if the opportunity exists. It has happened that sun-baths could be given as early as April and be continued into the month of October but, as a rule, it is not possible to begin before the end of May and some years, it must cease in September.

I have never noticed any ill results of the above-mentioned dosage which seems bold when compared with that of ROLLIER. Solar radiation, of course, especially in the ultraviolet spectral field is quite different at Leysin from that at Högbo.

The arc-lamps I used at first were two serie-coupled 30 amp. lamps of 55 volts of German make, but I afterwards changed to three 20 amp. lamps of the Finsen original model which proved superior to the German lamps. Quite recently I have got two 75 amp. lamps installed. Of these I have no experience worth mentioning. In the arc-lamp treatment the method indicated by Dr REYN



has been exactly followed excepting that, for practical reasons, I have not been able to give longer treatment than  $1\frac{1}{2}$  hours. The light-baths have been given every other day.

The quartz lamps I now use are manufactured by Quarzlampen-gesellschaft at Hanau, type U. V. H. for 220 volt alternating current, hanging from the ceiling. This type burns without ceasing which renders possible the treatment at the same time of 8 or 9 patients placed in a ring around the lamp. At the first treatment the patient sits for 15 mins at a distance from the lamp of 150 cm. This distance is preserved during the second to the fifth sittings, but the time is increased successively to 20, 30, 40 and 60 mins. The latter treatment-duration is maintained afterwards, but the distance is diminished during the 6th to 9th sittings to 125, 100, 80 and finally 66 cm. I am usually content with 60 mins treatment at a distance of 80 cm.; but have some times gone up to 2 hours without any drawback. Departures must sometimes be made from this plan owing to abnormally strong skin-reaction or other circumstances which demand caution. Attention must also be paid to the age of the burner and one must be more cautious when a new burner is used.

The quartz-lamp treatment is also employed on alternate days.

In order to utilize radiation which would otherwise be wasted, I make use of reflecting screens of chalked drawingpaper so placed that the patient sits between the lamp and the screen. The walls of the room are white-washed.

Much has been written of the effect of the various lightsources. The sun is generally deemed best. The great value of arc-lamps is generally acknowledged. As to quartz-lamps various opinions prevail. REYN<sup>1</sup> does not deny to the quartz-lamp a certain value when arc-lamps are not to be had but says that one must not expect anything like such good results from the quartz-lamp as from the arc-lamp. JESIONEK<sup>2</sup> considers that the superiority of the arc-lamps to the quartz-lamp is by no means proved and says in another place<sup>3</sup> that he still prefers the quartz-lamp to all other lamps. In Germany the quartz-lamp is widely employed and appears in general to enjoy a good reputation. I have not made any systematic comparisons and have only a slight experience of the most powerful (75 amp.) arc-lamps so I dare not express any definite opinion. The general impression I have hitherto obtained has led me to expect about the same effect whether I prescribe for a patient ordinary

<sup>1</sup> Strahlentherapie Bd XIX H. 1. P. 17 (and elsewhere).

<sup>2</sup> Klinische Wochenschrift 2 Jahrg. N:o 19.

<sup>3</sup> Strahlentherapie Bd XVI.

irradiation with a 220 volt quartz-lamp or with three 20 amp. arc-lamps. At any rate no *great* difference of effect has appeared. The quartz-lamp rather frequently has been declared inferior on purely theoretical grounds, viz. the one-sided composition of the radiation and its small power of penetration. This argument cannot possibly be accepted as long as we do not know with certainty and in detail in which part of the spectral field effective radiation is to be sought nor at what depth under the surface of the skin this radiation has its primary points of attack.

In any case the quartz-lamp has, in my opinion, done very good surface. To its credit must also be mentioned its cheap running cost and its usability for alternating current. The future must show if different indications for the different lightsources can really be established.

#### Account of Cases Treated

The number of patients suffering from surgical tuberculosis who have been treated at the hospital since 1914 when light-treatment was introduced is rather more than 500. Out of these about 350 have undergone a more or less complete light-bath cure. Those who for various reasons have had less than twenty lighthours are excluded. All ages are represented except earliest infancy and late old-age after 72.

A large number of the patients have suffered from tuberculosis of the lungs at the same time, often far advanced. The course of the lung-tuberculosis, in such cases, is generally decisive to the final result of the treatment. This, of course, makes it more difficult to judge the value of the method for surgical tuberculosis when considering this by itself. It is a striking fact that the so-called surgical localizations of the disease often seem, as it were, to go their own way. It is not seldom found that external tuberculous foci are healed at the same time as the lung tuberculosis incessantly progresses towards mors. (See e. g. Case N:o 16 below.)

Only a few cases have been treated ambulatorily. Most have been cared for at the hospital and there enjoyed the combined treatment of which I have previously spoken. Thus the favourable results are the effects of several co-operating factors and, as a rule, it is not possible exactly to fix the share of the light-treatment. Neither has it any great practical significance since, no doubt, it is desirable that the methods in question should be allowed to co-operate. A summary statement of the results of the treatment, with regard to what I have just said and to the heterogeneous nature of



the material, would be of doubtful advantage. Time and space do not allow a thorough account to be given of a large number of cases. I will therefore select a few cases which seem to be of interest in this connection and, for the rest, merely summarize my experiences and impressions.

The cases described below have been selected from those whose later fortunes I have been able to trace for a sufficiently long time to check the durability of the good results attained.

*Case No 1. Maria K. K. 38 years old. Journal no. 233/1921. Diagnosis: Spondylitis tbc. + tuberculosis pulmonum et lymphogland.* At 18 had pleurisy. At 34 consumption was diagnosed. Since then glands and fistulas on the neck. Somewhat later spondylitis cervicalis with paresis in both arms and incipient numbness in the legs. Improvement under orthopaedic treatment. The last half year increased secretion from the fistulas on the neck.

At the hospital we found: tuberculosis in the upper part of both lungs. small glands of the neck and rather freely secreting fistulas, subfebrile temperature. The WEISS' reaction and the diazo-reaction positive. No albumen in the urine. X-ray: destruction and partial compression of C<sub>II</sub>, C<sub>III</sub>, D<sub>I</sub> and D<sub>II</sub>. Pain when trying to turn the head.

The patient was put into a plaster of Paris bed and treated with arc-lamps, a quartzlamp and the sun. With a rising temperature a large abscess was formed on the right side of the neck behind musc. sternocleidomastoideus. The abscess was punctured. Later on a fistula was formed which for a long time secreted matter abundantly. In the neighbourhood of the fistula the skin was for a long time vividly red, infiltrated and very tender. (In all probability secondary infection.)

After one year's treatment all the fistulas were healed and the spondylitis symptoms had disappeared with the exception of limitation of mobility. The temperature for a long time normal. Diazo-reaction negative. The patient was allowed to get up and went home after 13½ months' treatment. She had had 193 light-bath hours.

The patient's doctor reports that, three years after the close of the cure, all the fistulas are still healed. Neck movement limited. No pain. Spondylitis healed. No glands on the neck. The patient manages the household.

*Case No 2. Kerstin H. 31 years old. Journal no. 201/1918. Diagnosis: Spondylitis tuberculosa.* For two years had pains in the back radiating towards the hips. Later shivering fits and swelling in the right groin. The patient, however, had remained up and worked. She was admitted first into the Falun hospital on 28. 4. 1918. From the journal kept there the following may be quoted: »Gibbosity at the third lumbar vertebra — not tender to pressure. X-ray: Compression of the 2:nd and 3:rd lumbar vertebrae. Immediately within the right spina iliaca a swelling as big as a goose-egg. A fluctuating abscess also in the left fossa iliaca.» A plaster of Paris bed was prepared and the patient was moved to Högbo Infirmary on 31. 5. 1918.

Lungs: No remarks. Cystitis from colon bacillus infection. Normal temperature. Treatment: Plaster of Paris bed + sun and arc-lamp bath, irrigations of the bladder and urotropin.

The cold abscesses increased in size during the first months. The left spread under lig. Poupart down on the front of the thigh. After 5½ months

the abscesses were completely absorbed. No puncture had been made: spontaneous perforation had not taken place. The cystitis symptoms remained for a whole year. After a treatment of 1 year and 3 months the patient went home with a plaster of Paris corset. She walked well after becoming accustomed to being up. No symptoms from spine or bladder. She had had sun and arc-lamp 99 hours together.

In June 1925 —  $5\frac{3}{4}$  years after her discharge — the patient was working quite like a healthy person, managed her house and had kept well all the time.

*Case No 3* Sonja N. 4 years old. Journal no. 185/1918. *Diagnosis: Spondylitis tuberculosa + tuberculosis articul. talo-crural. sin. + tuberculosis lymphogland + otitis media suppurativa bilateralis.* Ill for two years. Moved to Högbo from the Falun hospital where the patient had been four months and where, inter alia, the following remarks had been made: "Sores and scurf around the nose. Enlarged lymphnodes on both sides of the neck, fistula on the right side. Gibbosity corresponding to L. IV. Abdomen large. No sure signs of effusion in the abdominal cavity. Liver perceptible half an inch below the edge of the thorax. Fungus in the left ankle-joint with an abscess behind the inner ankle-bone and one somewhat higher up on the leg. Running from both ears. X-ray showed L. I—III strongly deformed and partially destroyed. Strong atrophy of the bone in the left foot. Astragalus somewhat deformed. The patient was treated at the hospital, had plaster of Paris bed, and the abscess at the ankle-joint was punctured. On her discharge from the Falun hospital the following entry was made in the Journal: 'General condition rather good. The fistula on the neck as before. Foot approximately unchanged. Slight secretion from the left ear, abundant from the right. Liver as before. Hump somewhat diminished.' The patient was taken straight to Högbo Infirmary where light-treatment was begun and the plaster of Paris continued.

During the first month the temperature was high ( $39-40^{\circ}\text{C}$ ); it fell very slowly and was very seldom normal during the whole of the first year. The patient suffered from obstinate diarrhoea the first year.

In the earlier part of the treatment some new fistulas were formed — at the nape, on the neck and at the ankle-joint. These were healed after about four months but the old neck-fistula only after 1 year and 4 months. The running from the ears ceased after one year's treatment. On one occasion symptoms of ileus suddenly appeared. These proved to be connected with a cold abscess which had been formed in the left of the abdomen. The abscess was punctured and about 60 ccm. of matter were drawn out. The abscess gradually decreased and was no more perceptible after half a year. The bulk of the ankle joint diminished continually. The general condition improved marvellously. After two years the patient was allowed to get up with a plaster of Paris corset. She was discharged two months later. The ankle-joint was completely healed but its mobility was somewhat restricted. The hump was less prominent than at her admission. Altogether the patient had 144 hours light-bath. (Sun, arc-lamp and quartzlamp).

According to a report from the dispensary nurse five years after the patient's discharge, she is well and healthy, though thin. She has all the time been healed. Gait but slightly stiff. She goes to school.

*Case No 4.* Gunnar P.  $3\frac{1}{2}$  years old. Journal no. 242/1923. *Diagnosis: Tuberculosis artic. cubiti sin., pulmonis dx.* Left elbow swollen for

a year, fusiform. Over the olecranon a deep shilling-sized dirty ulcer, in the bend of the elbow an ulcer rather less than a farthing in size and on the outside of the arm a small fistula. Rather abundant secretion. X-ray showed spotty rarefaction in the upper part of the ulna the outline of which corresponding to the incisura semilunaris was uneven and jagged. Plaster of Paris bandage, arc- and quartz-lamps 168 hours, sun 31 hours.

After eight months' treatment the ulcers and fistulas were healed; mobility of elbow slight. Discharged without plaster of Paris after 13 months' care. Fourteen months later the dispensary nurse reports that the boy is very well and has remained healed all the time. The arm can be stretched almost straight and bent to about a right angle.

Case No 5. Axel E. 44 years old. Journal no. 152/1913 and 89/1916. *Diagnosis: Tuberculosis carpi sin., pulmonum.* Pleurisy at the age of 20. Tuberculosis of the wrist for 2 years. Consumption diagnosed half a year ago. Tuberculosis of both lungs, stage III + T B. Difficult breathing at movement. Considerable swelling above the left wrist and the lower part of the forearm. Blue red discoloration of the skin and fluctuation on the volar side. No tenderness or but slight. Practically no mobility in wrist and fingers. The hand could not be held in a horizontal position without support. Fingers in a claw position. Normal temperature.

X-ray investigation demonstrated a progressive destruction of the bones and joints of the carpus proceeding from the radio-carpal-articulation and likewise, changes in the lower parts of the radius and ulna.

The arm was placed in a sling. Treatment with quartz-lamp. Two fistulas rose up on the wrist whose swelling decreased. General condition improved. The patient was cared for at the infirmary for 1 year and 3 months and had altogether 249 hours' light-bath entirely with the quartz-lamp. General condition at discharge was particularly good. Increase of weight was 12.4 kilogrammes. Fistulas healed. Wrist considerably narrower but still deformed, slight mobility in wrist and finger-joints.

After one year spent at another sanatorium with no other treatment than the ordinary sanatorium cure the patient returned and was now treated for seven months. He had the quartz-lamp 117 hours, sunbath 30 hours. Both active and passive mobility in the wrist gradually increased to 45° flexion and extension and about equally great pronation and supination. The mobility of the fingers was also increased. Tuberculous bacilli could not now be demonstrated in the sputum.

The X-ray plate showed that most of the wrist-bones were conglomerated with each other and the radius into a block with considerable, but irregularly deposits of lime.

Eight years after the last treatment ended I have received a communication to the effect that the patient has been working for several years as a lumber-man and performed the same tasks as his healthy mates, being well and strong.

It is a well-known fact that surgical tuberculosis in old age has little tendency to heal. SOREL<sup>1</sup> says hereof: »Chez le vieillard (et lorsqu'il s'agit de tuberculose, c'est l'âge de 50 ans à peu près que

<sup>1</sup> Quelques généralités sur la tuberculose ostéo-articulaire. Presse médicale 1921 Nos 2 et 11.

l'on fixe comme limite à l'âge adulte) la question change encore. On ne peut plus guère compter sur la guérison de la tuberculose osseuse.»

The two oldest of my light-treated patients were both healed. Their age at the close of the treatment was 72 and 70 years respectively. From this point of view especially these cases may deserve mention.

Case No 6. Maria J. Born 1845. Journal no. 130/1914 and 144/1917. *Diagnosis: Tuberculosis carpi et metacarpi, tendovaginitis tuberculosa, tuberculosis pulmonum, stage III.* Consumptive for at least 6 years. An affection of the hand for one year. Half a year before admittance to the infirmary a resection of the upper part of os metacarp. II was made. The sheath of the flexor longus pollicis was opened during the operation on which matter spurted out of the same.

At the beginning of the treatment the patient had fistulas on both the dorsal and volar sides corresponding to the place for os metacarp. II. Considerable restriction of mobility in all the joints of the hand. X-ray: Spotty rarefaction of os capitatum, metacarp. III and IV. The articular surfaces between these bones destroyed. Upper part of os metacarp II was wanting. Temperature normal. 0 alb.

After three months' treatment with sanatorium care and quartz-lamp (79 hours) the fistulas were completely healed and mobility somewhat increased. The condition of the lungs was improved.

One and a half years after the close of the treatment the condition was still good and the fistulas still healed. No pain or tenderness in the hand. The mobility of wrist and thumb quite normal, the fingers' mobility limited. Somewhat later the patient had pneumonia which reduced her strength. The hand began to swell again. A swelling also appeared on the left elbow. Both were opened and scraped out and the patient underwent X-ray treatment for the hand twice. Somewhat later the patient coughed up blood.

The patient was again admitted to the Högbo Infirmary three years after her discharge and four months after the latest operation. She now had a swelling with fistula in the region of 2nd metacarpo-phalangeal joint of the left hand. The skin was purple. On the inside of the left elbow two fistulas. The X-ray plate showed that the new affection of the hand probably proceeded from the distal part of os metacarp. II left after the first operation which displayed rarefaction and condensation in patches. The joint towards the phalanx was intact. There was no perceptible focus in the bone corresponding to the fistulas at the elbow.

The patient was treated with the quartz-lamp for 22 hours. During her stay at the Infirmary she had blood-coughing (150 ccm) but still improved both as regards general condition and the local ailment. On her discharge all the ulcers were as good as healed. Complete healing took place after her arrival home. The patient was advised to undergo X-ray treatment and received it polyclinically for one year.

In June 1925 — 8 years after her discharge — the now octogenarian patient is remarkably well, being up and about. The hand has remained healed all the time. The mobility of the index is limited, the mobility of the other fingers, thumb and wrist is good.

Case No 7. M. Ulrika J. Born 1851. Journal no. 424/1919. The other old person had a pronounced *cardio-arteriosclerosis + tuberculosis in tarsus with fistulas*, swelling, tenderness and restricted mobility. The patient had not walked on her foot for about two months. During the whole of the first year of treatment the temperature was very unsteady with frequent cold fits and rises of temperature to 39 or 40° C. Complete healing was attained in the case of this septuagenarian after 1 year and 8 months' sanatorium cure with 123 hours' quartz-lamp, 19 hours' sun and 50 hours' arc-lamp.

Weight increase 15 kg.

Four years after the close of the treatment the patient is still well and healed and walks without impediment.

Case No 8. Edvin A. 25 years old. Journal no. 321/1923. *Diagnosis: Coxitis tuberculosa + tuberculosis pulmonum*. Symptoms of coxitis for 2 years, at times severe pain. Has been at different hospitals more than a year (Plaster of Paris and extension bandages). Fever during the whole of this time, 38—39°. Pain whenever extension was not employed.

On admittance here there was pain in the left hip. Plaster of Paris bandage had been applied to render the journey here possible. The pain ceased when the plaster of Paris was changed for extension. No perceptible shortening of the leg. Pain when attempting to move, on which the pelvis at once accompanies. X-ray: Caput femoris deformed, articular cartilages completely destroyed. Patchy rarefactions in caput and acetabulum.

Slight charges on both lung apices. 0 alb. WEISZ' urochromogen reaction faintly positive. Temperature about 38° in the afternoon.

The patient had sun, arc-lamp and quartz-lamp treatment for altogether 152 hours over a period of 8 months. Temperature became normal after 2½ months. Suspension stability values on admittance 22, 56, 110. Five months later 4, 7, 56. When the patient left the infirmary, he was free from pain; hip-joint ankylotic. The patient walked with crutches. General condition was excellent. The WEISZ' reaction as well as the diazo-reaction negative. Weight increase 14.5 kg.

Fourteen months later condition still good. The patient walks with a crutch but can also manage without the crutch though he then tires quickly.

Case No 9. Elin O. 9 years old. Journal no. 466/1921. *Diagnosis: Coxitis tuberculosa*. Symptoms from the hip joint since March 1921. A plaster of Paris bandage was applied in April. X-ray plate 2/5 1921 (Dr. SAUL): 'In the right caput femoris an attenuation the size of a hazel-nut in the bone-picture, surely a tbc focus. Acetabulum enlarged.' The patient was first cared for at home. On 15/8 there was an evident change for the worse wherefore she was admitted to the Falun hospital. X-ray photo 15/8 1921: 'The whole of caput and a large part of collum now destroyed. Acetabulum considerably enlarged with uneven contours. The process progressing rapidly.' After staying 2½ months at the Falun hospital the patient was moved to Högbo Infirmary.

On admittance here there was pain at every attempt to move the hip-joint and at pressure along the line of the leg. No shortening of the leg. An abscess on the anterior side of the joint. Later on a large abscess arose in the region of trochanter major. The first abscess formed a fistula on the inside of the thigh. Temperature normal, 0 alb.

The patient was at the hospital for one year and during that time had



both arc- and quartz-lamps (160 hours) as well as sun-bathing (24 hours). She went home with plaster of Paris bandage and crutches. The fistula was then healed, the abscesses quite gone. No tenderness and no spontaneous pains in the hip. The leg was kept somewhat abducted and flexed.

Two years and eight months later the patient's doctor reported that she was well, walked without support somewhat limpingly but otherwise without impediment. Complete ankylose in the hip-joint. The thigh deviates from the extended position to the extent of about 30°.

*Case No 10.* Gunnar M. 11 years old. Journal no. 193/1921. *Diagnosis: Gonitis tuberculosa.* Symptoms in the left knee joint for the last half year. Plaster of Paris bandage was applied at the Falun hospital whence the patient was sent here. Left knee joint swollen, capsule thickening, arrosion of the cartilage of the internal condyle of the femur, tenderness around the cavity of the joint. Pain on attempting to move. Atrophy of the musculature of the thigh.

Arc- and quartz-lamps 179 hours + sunbath 27 hours, plaster of Paris bandage, extension. Subfebrile temperature during the first month of treatment. The swelling of the joint increased at the outset; punctures were repeatedly made. Two fistulas were formed, were open about half a year and secreted matter. Gradually the tenderness vanished and the fistulas were healed. The mobility of the knee joint equal to approximately 25°. The patient went home with a plaster of Paris bandage after a stay of 1 year and 4 months at the infirmary.

Three years later the dispensary nurse reported, that the patient was well and strong. Uses a leather bandage, but can walk well without it. The mobility of the joint equal to 90°. No limp.

*Case No 11.* U. Anders A. 22 years old. Journal no. 278/1918. *Diagnosis: Tuberculosis pedis.* The disease had existed for 7 years. It commenced after trauma. Constant flow of matter from fistulas on the foot for about six years in spite of the treatment at a sea-coast sanatorium and scraping out of the fistulas. Acute hemorrhagic nephritis three years ago.

The musculature of the right leg atrophic. The right foot markedly shortened and considerably swollen especially on the outer and under side. A fistula with abundant secretion of matter on the outer part of the dorsum of the foot at about the boundary between tarsus and metatarsus. X-ray: Destruction of the anterior ends of calcaneus and astragalus and the posterior ends of the metatarsal bones. Ossa cuneiformia and os cuboideum appear to have been removed in great part or to have been eaten away by caries. — Lungs: no remark. 0 alb.

Treatment: sun, quartz-lamp and arc-lamp. Two new fistulas were formed one of which was near the old one, the other below the inner ankle. The swelling diminished, secretion gradually ceased, the general condition improved. After a time, however there appeared albuminuria with red blood-corpuscles in the urine-sediment. Blood pressure 140/95 mm.

The amount of albumin rose to 12‰.

After about two years' treatment the patient could support himself on his foot, without difficulty. After 3 years and 5 months' treatment all the fistulas were completely healed. The patient could walk without sticks. Weight increase 21 kg. Albumin was still present, likewise red blood corpuscles in the sediment. General condition otherwise excellent.

The patient had had sunbathing, quartz- and arc-lamps for altogether 416 hours; moreover, during the latter part of the time X-ray treatment. (28 times I S. N. through 1 mm alumin.)

In March 1925, three years after leaving the infirmary, he was in very good health, walked without difficulty and used no support. No pain. The foot has been healed all the time. Mobility restricted. X-ray photograph showed advanced deformity of tarsus and metatarsus. Astragalus was dislocated so that its anterior end with attached os aviculare and a fragment probably of os cuneiforme I pointed obliquely inward and forward. Of the metatarsal bones there remained only the distal halves resting on the surface of astragalus and naviculare. All bone contours sharp. Glassy atrophy in all the bones of the foot as well as the lower end of tibia and fibula.

The urine still contained traces of albumin.

Case No 12. Gottfrid O. 21 years old. Journal no. 351/1920. *Diagnosis: Tuberculosis artic. talo-crural. sin., spondylitis dorso-lumbalis.* Pleurisy 1916. In 1917 a toe of the left foot was amputated for tuberculosis. In 1918-1919 pains in the back with formation of gibbosity. For some years at times swelling in the left ankle. In March 1920 the patient became unable to walk; the ankle was swollen, red, and tender when moved. Treated with plaster of Paris bandage.

Admitted to the infirmary  $3/7$  1920. Marked diffuse swelling round the left ankle with three fistulas. Below and behind the inner anklebone considerable swelling with fluctuation. Oedema on the dorsum of the foot. X-ray: The articular surface of astragalus towards tibia destroyed, irregularly formed. Gibbosity at the transition between dorsal and lumbar vertebral column. No pain, no tenderness. No fever.

For safety the patient was given a plaster of Paris corset which was removed after  $3\frac{1}{2}$  months when no signs of spondylitis observed.

Treatment: Bed-position. Arc-lamp. Three new fistulas were formed around the ankle. Abundant secretion of matter. The ankle gradually diminished in thickness. The secretion from the fistulas diminished. Still, after a year's treatment, a new abscess was formed anterior to the outer anklebone. After repeated punctures a fistula appeared.

The patient was discharged after being at the infirmary for 1 year  $8\frac{1}{2}$  months. He had then had light-treatment (sun and arc-lamp) altogether 259 hours. The foot now had normal configuration. All the fistulas were healed. Limited mobility in the ankle. The patient had long taken regular walks, using a stick.

Two years later the patient was again admitted for a short period of observation, when he underwent 20 hours light-bathing. The reason was a slight and transient swelling in the region of the ankle with no sign of a return of the articular disease.

In June 1925 (more than five years after the patient's leaving the infirmary the first time) he presented himself for examination. The foot had the normal shape. No fistula or swellings. Complete ankylose. No pain. Back called for no remark. The patient was rather thin and pale but otherwise well and doing agricultural work. X-ray plate showed synostosis between the tibia and astragalus. Abundant lime in corpus astragali.

Case No 13. Åke R. 2 years 3 months old. Journal no. 113/1917. For 1 year and 4 months multiple tuberculous foci of bones and soft parts. Spinae



ventosae: 3 foci on the left hand with considerable swelling of the soft parts and a number of fistulas, two osseous foci on the right hand, one such with ulceration on one toe. On the left forearm four fistulas, at the right elbow a fistula, one on the calf of the left leg and one above the left inner ankle. Two foci of the soft parts in the head, one osseous focus in margo infraorbitalis sin. and in the lower jaw with a fistula through the gingiva. A few small glands and a fistula on the neck, a few glands as large as cherries in the axillae. A fistula in the vicinity of the anus. Thus, in addition to insignificant glands there were 19 different tuberculous foci in various parts of the body.

Treatment: Quartz-lamp 103 hours, sunbathing 61 hours. During the period of treatment there appeared at the outset some new foci — an abscess on the right leg, an abscess on the dorsum of the right foot, a large abscess in the left ham and a focus in the sole of the left foot. Two sequestra issued through the fistula in the gingiva and one from each thumb. Some of the closed foci broke down and emptied themselves spontaneously, others were absorbed. The secretion from most of the fistulas was for a long time very abundant. The patient remained at the infirmary for 1 year and 8 months. His condition improved slowly but surely. On his discharge all foci, ulcers and fistulas were completely healed.

In June 1925 — 6 years after the close of the treatment — the boy was well and strong. He had a small tuberculid on the calf of one leg and a few small glands on the neck but otherwise no signs of tuberculosis. He had been well all the time.

Case No 14. Gustaf H. U. 20 years old. Journal no. 117/1915 and 125 1917. *Diagnosis: Tuberculosis lymphoglandularum, pulmonum.* On both sides of the neck colossal gland-swelling connecting in the anterior middle-line under the chin, almost meeting in the nape of the neck also. Detached portions are fluctuating. A large number of fistulas and ulcers with abundant secretion of matter. Oedema under one eye. Changes in the upper parts of both lungs. Evening temperature between 38 and 39° C.

The patient was treated with the quartz lamp two hours daily. Temperature became normal after about one month. The gland-mass lessened partly by direct absorption, partly after previous breaking down. During the first part of the time one new swelling after another was formed in quick succession farther down on the neck, above and below the collar-bone where, previously, no trace of such had been observed. They came up »like mushrooms» (reaction in previously latent foci?). These new foci broke down and were quickly healed.

After 9 months' treatment, 341 light-baths exclusively with the quartz-lamp, (no sunbathing) the large gland-masses had disappeared. Only five glands, the largest being almond-sized, were left on the neck. No less than 23 scars on the neck from healed fistulas. The state of the lungs somewhat improved. General condition excellent.

Owing to a relapse the patient returned to the infirmary 1 year and 4 months later. He now had light-bathing with the quartz-lamp for 39 hours and sunbathing 33 hours for 5 months. When the patient left the infirmary, all the glands had disappeared and the fistulas were healed with the exception of an insignificant scab-sore on the neck.

Eight years later I saw the patient again. He was in the best of health and able to work to full capacity. There were only a few pea sized glands

on the neck, no sores or fistulas. Half a year after his discharge a small wet sore had appeared in front of the left ear which had quickly healed. Otherwise there had been no recurrence of the disease.

*Case No 15.* Brita E. 38 years old. Journal no. 230/1922. *Diagnosis:* *Tuberculosis peritonei.* Had fallen ill with ileus symptoms some weeks prior to admittance. At the operation the following reports was made: »extensive tuberculous peritonitis with large tubercles, here and there large cheesy conglomerations with a small amount of ascites. The small intestine was strangled at one place by a stringy formation.»

Two weeks after the operation the patient was admitted to the Högbo Infirmary. The abdomen was found to be distended below the navel. In the recumbent posture clear percussion note, with upright posture dullness under the navel. Occasional nausea. Bowels very sluggish.

The patient had arc- and quartz-lamp treatment for 36 hours during a period of 2½ months.

At the outset the temperature was subfebrile but became normal after some weeks. The patient went home free from symptoms.

Three years later it was stated that the patient had been well all the time, though not so strong as before her illness. She was at work, however, and managed both household and farmyard without assistance.

The following case illustrates a rapid healing process which, in all probability can be ascribed to the quartz-lamp. This joyful result, however, was of brief duration since advanced lung-tuberculosis could not be arrested and, in a short time, brought the patient to his grave.

*Case No 16.* Frans B. 42 years old. Journal no. 100/1918. *Diagnosis:* *Tuberculosis linguae.* Consumptive for at least 3 years and 7 months. The last three years there had been an ulcer on the tongue which at times had caused severe pain when chewing and prevented the patient from eating dry bread etc. Local treatment without result.

Lung tuberculosis stage III, + TB, abundant sputum, low fever.

The anterior edge of the tongue as well as its under surface as far as the froenum were the seat of an ulceration with smeary-coated, deeply cloven sore-bed and irregular edges. The froenum was cankered away. Width of ulceration about 5 cm. The WASSERMANN test negative.

During the first seven weeks the quartz-lamp alone was employed. At the end of this period the following note was made: »The ulcer on the tongue is mostly healed, only at the froenum there remains a small ulcerated surface.» Afterwards the patient also underwent sunbathing — altogether 26 hours' quartz-lamp and 32 hours' sunbathing. After three months' treatment the ulceration was completely healed. The patient could now eat anything without difficulty and increased in weight. The treatment was continued for four months longer. No effect on the lungs worth mentioning apart from diminution of the amount of sputum. Four months after discharge the patient got fever and hemoptysis and died after five months. The tongue remained healed all the time.

The foregoing may suffice as examples of more or less successful cases where, in my opinion, light has been a contributory factor in the good result. A brief account like this can obviously not be so convincing as direct observations. I wish also to own my lack of experience with regard to comparable non-light-treated cases.

The greatest number of cases treated is comprized in the group tuberculous adenitis = 131 cases. (Small glands of the size of a hazel-nut and the like have not been included, but only more considerable swellings). Of these 95 progressed to complete or nearly complete healing. These results have been strictly checked. Those cases in which it was not possible to get the better of the *general* infection have not been reckoned as healed, even if the glands were caused to disappear.

A large number of the cases have been fistulous. It is a striking fact that softening glands are far more certainly acted upon than glands which don't break down. Even large gland-masses, however, can disappear by absorption without breaking down.

I have had good results from the combined treatment also in cases of spina ventosa and other forms of tuberculosis in the hand and foot, in spondylitis, coxitis, gonitis, tuberculosis in the elbow and in bone-tuberculosis which did not concern the joints. Tuberculous peritonitis is a profitable field for the treatment, likewise skin-tuberculosis.

Broadly speaking, my experience of urogenital tuberculosis is unfavourable. As regards tuberculosis of the kidneys I have, of course, only treated bilateral forms and unilateral forms after previous operation and one patient with one-sided kidney tuberculosis who refused to submit to an operation.

It was impossible to heal any of these, even though some looked promising for a time. One patient of this category went about with symptoms of tuberculosis of the kidneys for three years before seeking expert attention. Both kidneys were then shown to be affected and the patient was moved to the Högbo Infirmary for a trial of light-treatment. He had sun, arc-lamp and quartz-lamp for altogether 11 months. His general condition improved marvellously. Increase of weight 22,5 kg. Strong pigmentation appeared as a consequence of the light-treatment. Urinal distress which, at the outset, was felt every halfhour, was improved to every two hours. Improvement of the changes in the bladder was demonstrated by the cystoscope. The amount of red blood-corpuscles in the urine sediment was considerably diminished. The last sample of the urine examined here was free from albumin. The patient himself made

the interesting observation that, for a time, the urine was regularly bloody after every light-bath but not between them.

The patient exaggerated the importance of these improvements, felt well, demanded leave to go home and, in spite of warnings, took up heavy work in the woods. For a time he seemed to stand it remarkably well. Suddenly, however, anuria appeared, followed by mors. The disease had existed seven years at least.

I have, moreover, hitherto not succeeded in healing a foecal fistula whereof not a few have been treated. One of the patients who got a foecal fistula after an operation for tuberculous salpingo-oophoritis had, in addition, spina ventosa and other foci in the bones and joints of both feet which healed rather quickly, while the foecal fistula, even after six years, was still secreting matter. The patient also had albuminuria. For a period of two years the amount of albumin was about 12 % with rises to 30 %, but it has since diminished. The last year and a half only traces of albumin were found in the urine which once was even quite free from albumin. The general condition has markedly improved, but the fistula seems unaffected. It is noteworthy that there has been obvious improvement of the kidney symptoms, which is probably rare with suppuration going on.

In all groups of the surgical tuberculosis failures have occurred. I refrain from quoting figures which, after all, are not very enlightening.

During the early part of the treatment increased secretion from the fistulas is often observed, as well as other phenomena pointing to a local reaction in the tuberculous foci. It has been brought up against light-treatment that it is unable to prevent the occurrence of new foci even during the treatment itself. I believe it may even be said that, sometimes, (as in my cases Nos 13 and 14) it induces the formation of new foci. The cause of this is, probably, local reaction in formerly latent foci which, through these reactions, become manifest. New foci of this kind are, as a rule, quickly healed. It is possible that we have here the hastening of a development which otherwise would have begun later and proceeded more slowly.

### Contra-Indications

The assertion has been made that fever is a contra-indication and lung-tuberculosis likewise. Both these, in my opinion, are incorrect, at any rate if they are to form the basis of a general rule.

Fever, by itself, is no hindrance to the carrying out of the

treatment. Many times I have seen fever of long duration which had defied other treatment yield to light-treatment. But, of course, one would not give light-baths to a patient with a rising temperature accompanied by shivering fits, nor if the fever had in any other way strongly influenced the general condition.

The idea is often encountered that light-treatment is hurtful in cases of lung-tuberculosis. Local reactions occur in lung-tuberculosis, as in surgical tuberculosis at the beginning of a light-treatment cure: increased amount of sputum, increase of bacilli, rise of temperature, minor hemorrhages, increased extension of râles, pretty much as in tuberculin reaction and, like that, quickly passing away. It is apparently foci-reactions of this kind which have led many to deem lung-tuberculosis unsuitable for light-therapeutic treatment. Injury can, of course, conceivably arise in this way but, with careful observation of the patient and cautious dosing, the danger may be regarded as minimal. I have not as yet seen any permanent injury which I have had reason to ascribe to the effects of light-treatment although I have made extensive use of light in the treatment of lung-tuberculosis.

In rare cases I have forgone the treatment because of the sputum repeatedly containing blood after light-baths. I generally prefer not to give light-bathing during the first four or six weeks after any considerable bleeding of the lungs.

The possibility of a local reaction must be borne in mind and particular caution must be observed in all those cases where, on account of special circumstances, a reaction must be deemed to imply special risk.

Other definite and detailed contra-indications are scarcely needed.

### Indications

There has been much contention as to the treatment of surgical tuberculosis. The last few decades have witnessed an evident change of opinion in so far as the importance and value of general treatment is now universally acknowledged. Light-treatment is a part of the general treatment. Since experienced and critical surgeons have now affirmed that light-treatment, properly employed, tends to lessen mortality and to abbreviate the time of healing there would seem to be good reason to set up the claim that every case of surgical tuberculosis, as far as possible, may enjoy a general treatment of which light-treatment forms a part. Whether, in any special case or group of cases, a surgical operation should be un-



dertaken is another question in the answering of which the surgeon should have the final word. Merely to apply local treatment to a spina ventosa or to remove a tuberculous gland is just as wrong as to leave one suffering from idiopathic pleurisy to his fate after rendering him free from fever. Dr S. JOHANSSON in his previously quoted work, makes a statement which deserves our best attention: »A trifling spina ventosa in a young child coming from a poor home, particularly if there is any source of infection there, may be deemed to be in equally great need of hospital-care as e. g. a bad case of spondylitis. Meningitis is just as menacing in the first case as in the latter.» Case N:o 12 of which I have given an account in the foregoing deserves viewing in this light. In this case there was pleurisy in 1916, tuberculosis in a toe in 1917, symptoms of spondylitis in 1918 and tuberculosis of the ankle in 1920. It was only the last manifestation of the disease which led to a thorough hygienic cure with light-bathing. There is reason to suppose — at any rate now afterwards — that it would have been better if, after the pleurisy or, at least, in connection with the amputation of the tuberculous toe, the patient had received general treatment with light-bathing.

Thus, if local treatment alone must be deemed, in principle, insufficient for a general infection like tuberculosis, surgical and orthopaedic action are, on the other hand, in many cases unavoidable and there is nothing to prevent a combination of the methods.

Contemporaneous employment of light-bathing and X-ray treatment is, no doubt, suitable in many cases. I have seen good effects of this combination.

It is important that light-treatment should be continued for some time after the local foci have been healed.

The introduction of light-treatment undoubtedly marks a particularly welcome step forward in the treatment of surgical tuberculosis. Still, this method also acts slowly and is consequently expensive. Sometimes, too, it leaves us in the lurch. Its manner of working is still unexplained. When this has been revealed, we shall obtain a knowledge of the conditions of healing of tuberculosis which will perhaps bear fruit. It is, therefore, a matter of special urgency that, parallel with the practical employment of light-therapeutics, more purposeful and energetic scientific study should be devoted to its tuberculosis-healing principle.

## SUMMARY

This account is not intended to demonstrate the effectiveness of light-treatment in cases of surgical tuberculosis. This must be deemed to have been sufficiently proved before. The author has not had such a purpose in view when conducting his experiments. On the contrary, contemporaneously with the light-treatment, he has employed the sanatorium-cure, surgical and orthopaedic measures and, occasionally X-ray treatment. The histories of a few sick-cases have been given as examples of what has been accomplished and what has not been able to be accomplished by this combined treatment. These are concerned with patients whose later fortunes have been able to be traced for some considerable time after the close of the treatment.

During the early part of the treatment signs of reaction are often noticeable in the tuberculous foci. This prompts a certain caution. Lung-tuberculosis and fever are not as a rule, to be taken as contra-indications — contrary to a rather wide-spread notion. Every case of tuberculosis, consequently of surgical tuberculosis also, should enjoy general treatment in which, if possible, light-treatment should form an integral part. It should be left to a skilled surgeon to decide whether surgical and orthopaedic treatment should be used in addition. X-ray treatment may also be advantageously combined with light-treatment. A scientific investigation of the manner of action of the light-bath is greatly to be desired.

## ZUSAMMENFASSUNG

Der hier vorgelegte Bericht will nicht Beweise dafür liefern, dass die Lichtbehandlung gegen chirurgische Tuberkulose von Wirkung ist. Dies dürfte als bereits hinreichend erwiesen betrachtet werden können. Der Verf. hat seine Versuche auch nicht in diesem Sinne angeordnet, sondern die Lichtbehandlung im Gegenteil zusammen mit Sanatoriumbehandlung, oder mit chirurgischen und orthopädischen Massnahmen, oder bisweilen mit Röntgenbehandlung angewendet. Als Beispiel dafür, was damit erreicht wurde, und was mit dieser kombinierten Therapie nicht zu erreichen war, sind einige Krankengeschichten mitgeteilt. Diese betreffen Patienten, deren weiteres Geschick beträchtliche Zeit nach Abschluss der Behandlung weiterverfolgt werden konnte.

Man sieht in der ersten Behandlungszeit häufig Anzeichen einer Reaktion in den tuberkulösen Herden. Dies mahnt zu einer gewissen Vorsicht. Lungentuberkulose und Fieber betrachtet Verf. im allgemeinen nicht als Kontraindikationen — im Gegensatz zu der recht verbreiteten gegenteiligen Vorstellung darüber. Jedem Fall von Tuberkulose, also auch von chirurgischer Tuberkulose, muss entsprechende Allgemeinbehandlung zuteil werden, in der womöglich eine Lichtbehandlung inbegriffen sein soll. Die Entscheidung darüber, ob daneben auch chirurgische und orthopädische Behandlung anzuwenden ist, muss dem fachkundigen Chirurgen überlassen werden. Auch Röntgenbehandlung wird mit Vorteil mit der Lichtbehandlung kombiniert. Eine wissenschaftliche Erforschung der Wirkungsweise des Lichtbades ist höchst wünschenswert.



## RÉSUMÉ

Ce travail n'a nullement pour but d'apporter une preuve de l'efficacité de la photothérapie dans la tuberculose chirurgicale, efficacité qui paraît d'ores et déjà suffisamment établie. Les expériences faites par l'auteur n'ont d'ailleurs pas été dirigées dans ce sens; au contraire, on a recouru, simultanément avec le traitement photothérapique, soit à une cure de sanatorium, soit à des interventions chirurgicales ou orthopédiques, soit enfin au traitement röntgénéologique. Quelques observations montrent ce qu'on a gagné et ce qu'on n'a pu gagner avec ce traitement combiné; ces observations ont trait à des malades dont les destinées ultérieures ont pu être suivies pendant longtemps après la fin du traitement.

On observe souvent dans le début du traitement des signes de réaction dans les foyers tuberculeux. C'est là un fait qui invite à quelque prudence. La tuberculose pulmonaire et une élévation de température ne constituent pas en général, contrairement à une opinion fort commune, une contre-indication. Tout cas de tuberculose, et par suite tout cas de tuberculose chirurgicale, doit bénéficier d'un traitement général, dans lequel la photothérapie devra chaque fois que ce sera possible, constituer un élément. On devra abandonner à un chirurgien expérimenté le soin de décider l'opportunité d'un traitement chirurgical ou orthopédique simultané. Le traitement radiothérapique peut également être avec avantages adjoint à la photothérapie. Il serait fort à désirer que des recherches scientifiques fussent faites sur le mode d'action des bains de lumière.



## THE INFLUENCE OF CHEMICAL LIGHT BATHS ON THE BACTERICIDAL PROCESSES IN THE BLOOD AND THE SERUM

by

*V. Genner*

As a contribution to the research work which is being carried on with a view to analysing the influence of light on the blood, there appeared, in 1924, in the British Journal of Experimental Pathology, a paper by COLEBROOK, EIDINOW and LEONARD HILL, on: The effect of Radiation on the Bactericidal Power of the Blood. From the results obtained by those authors in the course of their experimentation it would seem that light-baths produced a temporary increase, at least, in the bactericidal power of the blood. The authors state that this effect was observed frequently — though not always — in rabbits and guinea-pigs, and in some cases in man. For measuring its degree, they used a method published, shortly before, by WRIGHT (WRIGHT, COLEBROOK and STORER: The Cultivation of Bacteria in the so-called »Slide-cells», The Lancet, 1922). As sources of light they employed the Finsen Light, quartz-light and ordinary sunlight; and the bactericidal effect was determined both for blood, serum and leucocytes. The period at which the bactericidal optimum was reached seemed to vary somewhat, according to the source of light employed and according to whether the determination was made for blood or for serum.

Although this increase in bactericidal power is not stated to have been observed in all cases, the published experiments nevertheless show it to have been so considerable that there can hardly be any possibility of its having been merely accidental. Further investigations bearing on this subject may therefore undoubtedly lay claim to more than a little interest, on account of the additional insight which they give us into the not yet definitely established principles underlying the therapeutic action of the light-baths.

At the instigation of Dr. REYN, my former chief, I have carried out a number of experiments in the same direction, at the labora-

tory of the Finsen Institute. It is true that I have worked on a line of technique different from the one employed by the British authors just named; still, I believe that, with certain modifications, my method offers a guarantee for exact results quite as complete as theirs.

A few of the experiments were made with defibrinated blood; but most of them were made with serum, either from human subjects or from rabbits. As sources of light both the Finsen Light and quartz light were used.

The experiments fall into three series. In each of these the technique was slightly different, but not essentially so.

For the first series I used a twenty-four hours' agar culture of *staphylococcus aureus*, which was first rubbed up in a physiological salt solution and standardised up to a known kaolin emulsion, and then diluted down to the bacterial strength used for the experiments. Within certain limits, that strength was made slightly different in each experiment, because it is known that the bactericidal process depends in a certain degree on the number of bacteria implanted in a definite quantity of blood or serum.

As it has been shown by others, and as also my own experiments go to prove, the normal human serum has no bactericidal effect on the staphylococci. Rabbit serum, on the other hand, usually has a slight, and in some cases a moderately strong, bactericidal effect; only in very rare instances is the effect totally absent.

It is evident that for the purpose of experiments whose object is to demonstrate variations in the bactericidal power, the most suitable test animals will be such whose serum is not too strongly bactericidal toward some definite strain of bacteria. In that respect, the combination: rabbits vs. staphylococci is excellently adapted to the purpose of these tests. Most rabbits will be found suitable; nevertheless it will be practical to make a test to determine, in a general way, the bactericidal power of the animal's serum, before using it for the light-bath experiments.

Before the animal is put under the light bath, the hair is removed from its back by means of some depilatory, such as barium sulphate. The blood is taken from the auricular vein — 2 to 3 c. c. each time: the first time, immediately before the light bath; the second time, from thirty minutes to one hour after; the third time, from two to two and a half hours after; the fourth time, three hours after. This is about the same time-schedule as was used by COLEBROOK, EDINOW and HILL.

As a rule, it will be possible to use a rabbit several times before the hairs grow out again, and before the blood-letting becomes

too great. A few animals were used four to six times, with the experiments being repeated every second day. In the case of a number of animals the abstraction of the blood was so difficult, however, that they could only be used once or twice.

The blood from the human subjects was taken, with similar intervals, from the ulnar vein, by means of a 5 c. c. syringe.

The duration of the light bath was: with Finsen Light, from one and a half to two and a half hours; with quartz light, about thirty minutes.

The determination of the bactericidal effect was always made on the same day on which the samples of serum were drawn, and these were placed in the refrigerator until used.

### First Series of Experiments

This series comprised: 12 tests of human serum (10 with Finsen Light bath, 2 with »Jesioneck» quartz-light bath); 13 of rabbit serum and 4 of defibrinated blood from rabbits (9 of the animal tests being with Finsen Light bath, and 8 with quartz-light bath).

For determining the bactericidal effect, I used the method indicated by WULFF<sup>1</sup>, which differs from the ordinary proceeding by the sowing being made, not in melted agar, but to a limited field of a solid culture medium contained in a Petri dish. The sowing is performed by means of a platinum loop of a certain size, and the Petri dish is, to that end, divided into fields, each about 3 cm. in diameter. As stated by WULFF, this method is very economic as regards both medium and serum, even when, for the sake of control, two samples are being sown from each of the tubes each time.

The bactericidal test is then carried out as follows:

	<i>Tube I</i>	<i>Tube II</i>	<i>Tube III (Control)</i>
Serum . . . . .	0.5 c.c.	0.1 c.c.	0
0.9 % NaCl. solution . .	0.3 »	0.7 »	0.8 c.c.
Broth . . . . .	0.1 »	0.1 »	0.1 »
Bacterial emulsion . .	0.1 »	0.1 »	0.1 »
	1.0 c.c.	1.0 c.c.	1.0 c.c.

The 0.1 c.c. of broth was added in order to counteract the disinfecting influence of the salt water. The total volume in each tube is 1 c.c. In tube I the serum is diluted 5:10; in tube II the dilution is 1:10.

<sup>1</sup> F. WULFF: On Bactericides. Acta Medica Scandinavica, vol. LX, p. 395.

Immediately after the filling of the three tubes had been completed, a sowing was made, for control, from tube III onto two fields of a Petri dish 15 cm. in diameter and divided into eight fields altogether. The tubes were then left standing in the thermostat for 3 hours, at 37°. After that time, a sowing was done, in double, from all the three tubes, onto the remaining six fields of the Petri dish, and the latter was placed in the thermostat for 18 hours, at 37°. At the end of that time the colonies were counted.

The culture medium used was a 6 per cent. agar.

*Number of colonies (Reading after 18 hours):*

	before	after
	3 hours in thermostat at 37°	
Tube I (containing 0.5 c.c. of serum) . . . . .	—	b
» II » 0.1 » » » . . . . .	—	c
» III (no serum. — Control) . . . . .	a	d

A complete table, showing the result of a test for bactericidal effect of the light will then look, for instance, as follows:

*White rabbit, exposed to arc light for 2 hours.*  
(Serum sown on broth agar)

	before	after
	3 hours in thermostat at 37°	
	read after 18 h. no. of colonies:	read after 18 h. no. of colonies:
A. <i>Before exposure to arc.</i>		
Tube I (containing 0.5 c.c. of serum) . . . . .	—	b
» II » 0.1 » » » . . . . .	—	c
» III » 0 » » » . . . . .	a	d
B. <i>½ hours after exposure to arc.</i>		
Tube I . . . . .	—	b 1
» II . . . . .	—	c 1
» III . . . . .	a 1	d 1
C. <i>2 hours after exposure to arc.</i>		
Tube I . . . . .	—	b 2
» II . . . . .	—	c 2
» III . . . . .	a 2	d 2
D. <i>3 hours after exposure to arc.</i>		
Tube I . . . . .	—	b 3
» II . . . . .	—	c 3
» III . . . . .	a 3	d 3

*What is chiefly of interest here, besides the relation of a to b, is the variations in the value of b, b 1, b 2 and b 3. As a matter of fact, those sowings would be sufficient; if I have noted the values also of c and d, through all the tests, it is partly because it could be done with very little additional trouble anyhow, and because it gave me a better basis for judging the stability of the method.*

That, in the different tests, I have worked with different densities of the bacterial emulsion (a) is because I believe it to be of considerably greater interest than to use variously diluted serum (50 per cent., 10 per cent.).

The temporary increase in the bactericidal effect noted by COLEBROOK, EIDINOW and HILL usually lasted for two-three hours, and seemed to be connected exclusively with the ultra-violet rays. In their experiments with rabbit serum they found the bactericidal optimum to occur about two hours after the irradiation.

For nearly all my experiments I used serum; only in four cases did I use defibrinated blood.

*Result of the first series of experiments:*

1) Normal human serum has no bactericidal effect as regards staphylococci. Nor was any such effect noted from the samples of serum tested by me.

As most of the patients with whom these experiments were made had undergone repeated light-treatment, it is furthermore seen that such treatment, even when continued for a length of time, does not produce any lasting bactericidal effect.

But *not even a temporary increase* in the bactericidal power, such as COLEBROOK, EIDINOW and HILL claim to have observed, did I find in any of my cases.

2) Rabbit serum, as I have already said, is nearly always slightly bactericidal as regards staphylococci; but in hardly any of the tests did the lightbath seem to produce the temporary increase in bactericidal power spoken of by COLEBROOK, EIDINOW and HILL. Only in experiments IX and X is there a slight increase two hours after the lightbath; but compared with the increase observed by those authors it is so slight that, to me, it seems to lie within the limits of variations either natural or, perhaps, due to some unavoidable error in experimentation.

It is true that the figures for the double sowings show some slight differences in the number of bacteria sown; but in no instance is that difference so great that an experimental error arising therefrom could possibly compromise results so marked as those observed by COLEBROOK, EIDINOW and HILL.

First Series of Experiments (I a)

	Exp. I Woman exposed to arc light 2 $\frac{1}{2}$ hours. Serum sown on broth agar	Exp. II Woman exposed to arc light 2 $\frac{1}{2}$ hours. Serum sown on broth agar	Exp. III Woman exposed to arc light 1 $\frac{3}{4}$ hour. Serum sown on broth agar	Exp. V White rabbit I ex- posed to arc light 2 hours. Serum sown on broth agar	Exp. VI White rabbit II ex- posed to arc light 2 hours. Serum sown on broth agar
<b>A. Before exposure to arc</b>					
tube I containing 0.5 cm <sup>3</sup> serum	— 15, 36 (26)*	— 48, 98 (73)	— abt. 400	— 14, 13 (14)	— 60, 75 (68)
tube II > 0.1 >	— 22, 23	— 45, 88	— abt. 400	— 71, 48	— abt. 200
tube III > 0 >	13, 28 (21) 17, 28	44, 50 (47) 98, 115	abt. 300 300—400 22-33	(28) 60, 150	300—400 250—400
<b>B. Just after exposure</b>					
tube I . . . . .	—	—	—	— 18, 29 (24)	—
tube II . . . . .	—	—	—	— 62, 39	—
tube III . . . . .	—	—	— 17, 21 (19) 90, 80	—	—
<b>C. 1 hour after exposure</b>					
tube I . . . . .	— 20, 35 (28)	— 80, 115 (98)	— 300—400	— 41, 38 (40)	— 80 (80)
tube II . . . . .	— 25, 32	— 92, 84	— 300—400	— 57, 135	— 200—300
tube III . . . . .	20, 35 (28) 28, 28	50, 60 (55) 170, 110	200—300 200—300 37, 28	(33) 70, 200	abt. 400 300—400
<b>D. 2 hours after exposure</b>					
tube I . . . . .	— 37, 38 (38)	— 85, 98 (92)	— 300—400	— 20, 18 (19)	— 100 (100)
tube II . . . . .	— 27, 16	— 86, 95	— 300—400	— 83, 116	— 200—300
tube III . . . . .	36, 18 (27) 33, 20	56, 64 (60) 102, 110	300—400 300—400 24, 26	(25) 120, 160	abt. 300
<b>E. 3 hours after exposure</b>					
tube I . . . . .	— 22, 44 (33)	— 83, 58 (71)	— abt. 300	— 23, 24 (24)	— 100, 150 (125)
tube II . . . . .	— 40, 30	— 116, 115	— abt. 300	— 70, 59	— abt. 200
tube III . . . . .	23, 40 (27) 23, 52	43, 78 (51) 76, 120	abt. 300 25, 46 (36) 120, 140	300—400	abt. 300

\* 15 and 36 colonies as result of the double sowing; mean average parenthetically.



## First Series of Experiments (I b)

	<i>Exp. IV</i> Patient exposed to mercury vapour lamp $\frac{1}{2}$ hour. Serum sown on broth agar		<i>Exp. VII</i> White rabbit IV expo- sed to mercury vapour lamp $\frac{1}{2}$ hour. Serum sown on broth agar	
A. Before exposure to m. v. l.				
tube I. . . . .	—	many	—	many
tube II. . . . .	—	many	—	many
tube III. . . . .	many	many	many	crowded
B. $\frac{1}{2}$ hour after exposure				
tube I. . . . .	—	many	—	many
tube II. . . . .	—	many	—	many
tube III. . . . .	many	many	many	crowded
C. $2\frac{1}{2}$ hours after exposure				
tube I. . . . .	—	many	—	many
tube II. . . . .	—	many	—	many
tube III. . . . .	many	many	many	crowded
D. $3\frac{1}{2}$ hours after exposure				
tube I. . . . .	—	many	—	—
tube II. . . . .	—	many	—	—
tube III. . . . .	many	many	—	—

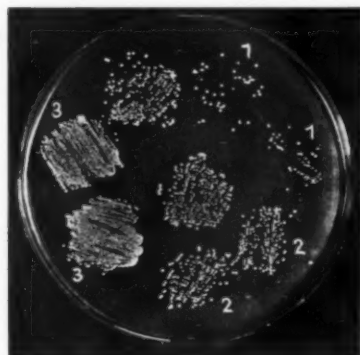
## First Series of Experiments (I c)

	<i>Exp. VIII</i> White rabbit V ex- posed to mercury vapour lamp 2 hours. Serum sown on broth agar		<i>Exp. IX</i> Grey rabbit VI ex- posed to mercury vapour lamp 2 hours. Defibrinated blood sown on broth agar		<i>Exp. X</i> Grey rabbit VI exposed to mercury vapour lamp 2 hours. Serum sown on broth agar	
A. Before exposure to m. v. l.						
tube I. . . . .	—	50, 60 (55)	—	500—700	—	100, 125 (113)
tube II. . . . .	—	150, 200	—	many	—	abt. 1000
tube III. . . . .	abt. 300	crowded	many	crowded	crowded	very crowded
			(700—1000)		(2000—3000)	
B. $\frac{1}{2}$ hour after exposure						
tube I. . . . .	—	18, 24 (21)	—	200—300	—	80, 125 (103)
tube II. . . . .	—	200—300	—	many	—	300—500
tube III. . . . .	300—400	crowded	many	crowded	crowded	very crowded
C. 2 hours after exposure						
tube I. . . . .	—	30, 50 (40)	—	100—200	—	65, 75 (70)
tube II. . . . .	—	400—600	—	abt. 200	—	200—300
tube III. . . . .	300—400	crowded	many	many	crowded	very crowded
D. 3 hours after exposure						
tube I. . . . .	—	21, 60 (41)	—	200—250	—	100, 125 (113)
tube II. . . . .	—	abt. 600	—	abt. 300	—	500—600
tube III. . . . .	300—400	crowded	many	crowded	crowded	very crowded

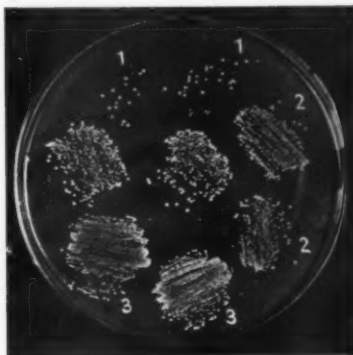
*Exp. VIII*

Rabbit V — 1. series of exp. — serum

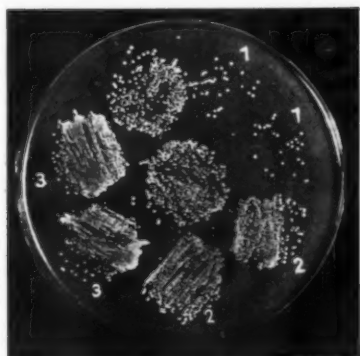
1  
Before the exposure to light



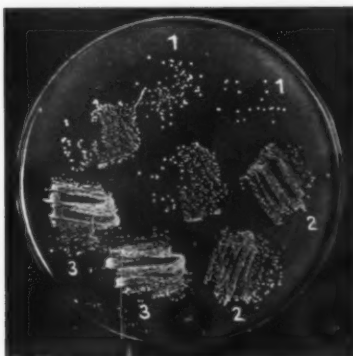
2  
1/2 hour after exposure



3  
2 hours after exposure



4  
3 hours after exposure

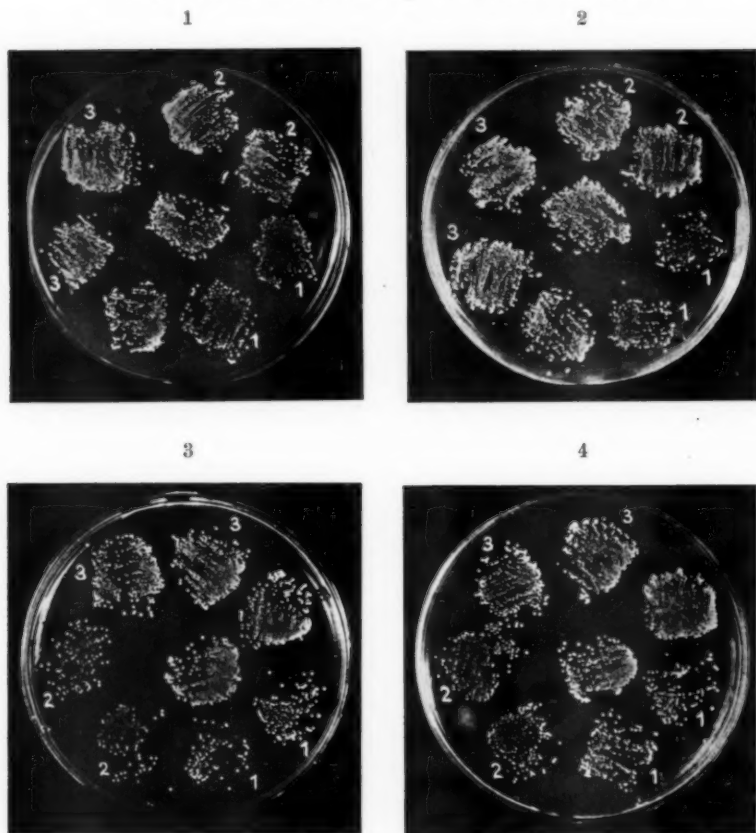


The double sowings from tube I, II and III are numbered 1, 2, 3  
The control sowings from tube III without number

Experimental errors in connection with the sowing will, of course, make themselves felt all the more strongly the smaller the number of bacteria sown; but already with figures not higher than about 100, there is a rather fair stability; and even with figures as low as 20 or 40 the variations are not particularly great.

*Exp. IX*

Rabbit VI — 1. series of exp. — defibrinated blood



Explanation Exp. VIII.

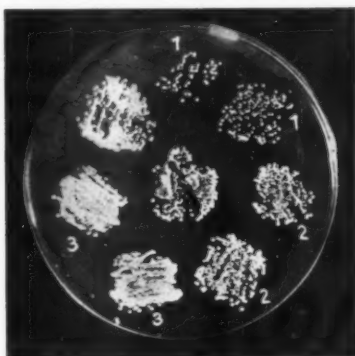
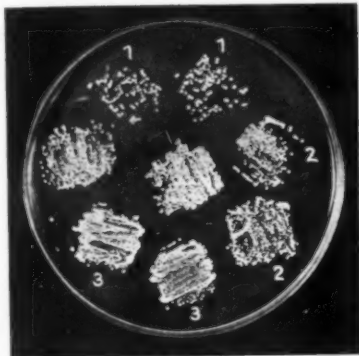
From the experiments IX and X, which were made, respectively, with defibrinated blood and serum *from the same rabbit*, it will be seen that the bactericidal effect is much more pronounced from the serum than from the blood. As a precisely similar observation was made in respect to another rabbit, the matter can hardly be the result of a mere chance, though I do not believe that any explanation of the phenomenon can be given at present.

*Exp. X*

Rabbit VI — 1. series of exp. — serum

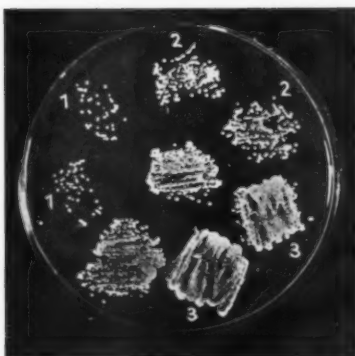
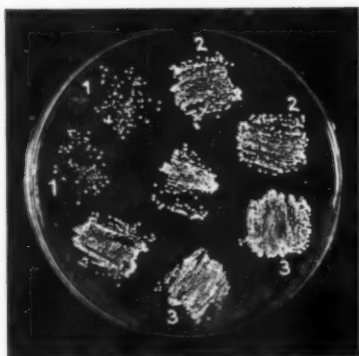
1

2



3

5



Explanation Exp. VIII.

**Second Series of Experiments**

WULFF's technique works with a first control-sowing of between 300 and 400 bacteria. With smaller quantities it is not reliable enough, according to my experiments.

Reasoning that, in the case of thin bacterial emulsions, a greater stability would be insured by sowing a larger quantity of the emul-

sion, I therefore decided to use — instead of the ordinary platinum loop — a special, spiral-twisted, cylindrical loop, holding about  $\frac{1}{30}$  c.c. of liquid.

Instead of the emulsion used for the first series of experiments — made of staphylococcus cultures grown in a solid nutritive medium and compared with standardised kaolin emulsions — I used here, as basis, an 18 hours' broth culture of staphylococcus aureus, which is more or less constant as regards the number of bacteria it contains. Some preliminary experiments were made, by sowing out from variously diluted emulsion, by means of the platinum loop just described, to Petri dishes containing agar divided into 7 fields.

<i>Exp. I.</i>	<i>Dish no. 1</i>	<i>Dish no. 2</i>
	number of colonies:	number of colonies:
	23	20
	29	38
	25	38
	32	23
	19	30
	29	18
	24	28
	33	30
	214	225
	mean average: 27	mean average: 28.1

<i>Exp. II.</i>	<i>Dish no. 1</i>	<i>Dish no. 2</i>
	number of colonies:	number of colonies:
	51	37
	55	50
	36	40
	58	48
	37	46
	43	38
	47	48
	269	308
	mean average: 44.8	mean average: 44

<i>Exp. III.</i>	<i>Dish no. 1</i>	<i>Dish no. 2</i>
	number of colonies:	number of colonies:
	51	51
	59	76
	62	76
	72	69
	74	75
	63	50
	73	57
	454	454
	mean average, in both cases: 65.	

The sowing with this loop was always done in exactly the same manner. For instance, it was always the same part of the cylindrical loop that was used for smearing the emulsion onto the agar surface.

As the quantity of emulsion transferred to the agar is greater by this method than when the ordinary platinum loop is used, it is necessary that the sowing should be done over a greater surface; but one fourth of the surface in a Petri dish 15 cm. in diameter will be sufficient.

#### Second Series of Experiments (II a)

	<i>Exp. I</i> Rabbit VII exposed to mercury vapour lamp $\frac{1}{2}$ hour. Serum sown on broth agar		<i>Exp. II</i> Rabbit VII exposed to mercury vapour lamp $\frac{1}{2}$ hour. Serum sown on broth agar		<i>Exp. III</i> Rabbit VII exposed to mercury vapour lamp $\frac{1}{2}$ hour. Serum sown on broth agar		<i>Exp. IV</i> Rabbit X exposed to mercury vapour lamp $\frac{1}{2}$ hour. Serum sown on broth agar	
A. Before exposure to m. v. l.								
tube I. . . . .	—	25	—	17	—	35	—	45
tube II. . . . .	—	51	—	48	—	90	—	70
tube III. . . . .	104	61	100	99	54	200—300	113	abt. 300
B. $\frac{1}{2}$ hour after exposure								
tube I. . . . .	—	47	—	17	—	20	—	70
tube II. . . . .	—	95	—	58	—	80	—	90
tube III. . . . .	95	67	110	120	68	abt. 300	110	abt. 300
C. 2 hours after exposure								
tube I. . . . .	—	6	—	16	—	7	—	33
tube II. . . . .	—	54	—	115	—	100	—	150
tube III. . . . .	120	66	93	170	85	abt. 200	95	abt. 400
D. 3 hours after exposure								
tube I. . . . .	—	40	—	40	—	13	—	80
tube II. . . . .	—	abt. 200	—	97	—	150	—	120
tube III. . . . .	110	abt. 400	90	170	54	300—400	96	abt. 400

As the figures for the mean averages show, the results of the sowings turned out fairly concordant.

In the following are set down the results of a number of tests carried out according to this method:

**Rabbit VII.** — Here we see, in *experiments I and III*, a considerable diminution in the number of colonies, two hours after the light-bath.



## Second Series of Experiments (II b)

	<i>Exp. V</i>		<i>Exp. VI</i>		<i>Exp. VII</i>		<i>Exp. VIII</i>	
	Rabbit XVIII exposed to mercury vapour lamp $\frac{1}{2}$ hour. Serum sown on broth agar		Rabbit XVIII exposed to mercury vapour lamp $\frac{1}{2}$ hour. Serum sown on broth agar		Rabbit XVIII exposed to mercury vapour lamp $\frac{1}{2}$ hour. Serum sown on broth agar		Rabbit XVIII exposed to mercury vapour lamp $\frac{1}{2}$ hour. Serum sown on broth agar	
		control sowings		control sowings		control sowings		control sowings
A. Before exposure to m. v. l.								
tube I . . . . .	21	35 41, 58, 55 (47)	4	6, 2, 0 (3)	3	3, 0, 2 (2)		
tube II . . . . .	49	120	6	—	56	—		
tube III . . . . .	120	140 abt. 400	62	300-400	120	300		
B. $\frac{1}{2}$ hour after exposure								
tube I . . . . .	19	35 100, 48, 60 (61)	0	4, 6, 2 (3)	1	1, 0, 2 (1)		
tube II . . . . .	42	130	29	—	45	—		
tube III . . . . .	100	145 abt. 400	69	70	90	abt. 500		
C. 2 hours after exposure								
tube I . . . . .	21	63 41, 80, 61 (56)	7	10, 15, 7 (10)	3	5, 2, 12 (5)		
tube II . . . . .	33	140	64	—	55	—		
tube III . . . . .	110	139 abt. 400	56	300-400	110	abt. 300		
D. 3 hours after exposure								
tube I . . . . .	12	80 100, 100, 59 (84)	2	14, 9, 8 (10)	3	13, 19, 12 (12)		
tube II . . . . .	20	141	56	—	90	—		
tube III . . . . .	122	145 abt. 500	33	150	111	120		

This may possibly be due to an increase in the bactericidal power of the serum; still, that explanation is rendered somewhat doubtful by the fact that no similar effect is observed in *experiment II*, with the same animal.

**Rabbit X.** — Here also, there is a slight diminution in the number of colonies, two hours after the light-bath (c., tube I), though very much less than in *experiments I and III*. It is possible that this may be explained as indicating a slightly increased bactericidal activity; but the difference between the number of colonies here (33) and in the other samples of serum (45, 70, 80) is so small that, on the other hand, we cannot dismiss the possibility of it being merely a matter of variations due to unavoidable errors in experimentation.

**Rabbit XVIII.** — In *experiment V* there is no diminution in the number of colonies two hours after the light-bath, but after three hours a slight diminution is noticed. But here we are probably down to so small quantities of bacteria that it is the method of sowing which becomes too inexact in its working. Nor in *experiment VI* is any increase in bactericidal effect observed two hours after the light-bath. — In this case, 3 extra sowings were made, for the sake of control, from tube I, in ordinary samples of serum. The figures for these sowings show some rather considerable variations, but do not otherwise alter the picture produced by the first sowing from the same tube. — The same is true as regards *experiments VII and VIII*; but here we are undoubtedly dealing with so small quantities of bacteria that the method itself fails to work properly.

Thus, to sum up the result of the experiments in this series, we see that in experiments I, III and IV there is a possibility of the diminution in the number of colonies after sowing from the tubes no. I being due to a passing increase in bactericidal activity, reaching its maximum 2 hours after the light-bath; though it is by no means certain that this explanation is the right one. Alone the fact that, under exactly identical conditions of experimentation, the same effect is not observed as invariable in consecutive tests with the same animal (see exp. II), would seem to indicate that other factors may have contributed to the result.

What is absolutely certain, however, is the increase in bactericidal power of the serum from rabbit XVIII, as observed in the two last experiments with this animal (VII and VIII), in contrast to what resulted from the two first ones (V and VI). We have here a condition of which I shall speak more fully in connection with the following series of experiments.

### Third Series of Experiments

It will have been noticed that the only difference in the technique employed, respectively, for the first and second series of experiments consists in the different form of the platinum loops used for the sowing. The weak point in both methods comes out when it becomes a question of sowing from thin emulsions (i. e. emulsions containing only feeble quantities of bacteria), because, with the latter, experimental errors are far too likely to have a bearing on the results obtained. Still, those results may always be counted on to be rather more exact when the spiral loop is used, than with the plain one; so that, when using the former, it will be possible to work with the thinner emulsions without abandoning the main principles of the chosen technique.

As already stated, the spiral loop used in preparing the second series of experiments held  $\frac{1}{30}$  c. c. of liquid. As the tubes from which the sowing is done contain 1 c. c., this is the same as to say that the loop will hold one thirtieth part of the contents of a tube. It then lies near to suppose that more constant results might be obtained by sowing out the whole content of the tube. But this would again imply the use of a much larger surface of agar. The advantages of the modification suggested by WULF lies, as he has pointed out himself, in the fact that it is both simpler and more economic.

As sowing-surface for 1 c. c. of emulsion we should hardly be able to get along with less than one whole Petri dish, 15 cm. in diameter, if the counting of the colonies were to be anyways nearly exact. This would mean — if the experiments were to be carried out to the same, full extent as in the two first series — the use of 16 dishes in all; and, besides, the counting of the colonies resulting from the sowings from tubes II and III would become an almost unsurmountable task.

I therefore confined myself to making sowings only from the four tubes no. I (besides from the control tubes, of course); as the sowings from tubes II and III can hardly be supposed to present as much interest.

A greater interest undoubtedly attaches to the use of variously diluted bacterial emulsions.

The contents of the four tubes no. I were, as in the foregoing tests:

Serum . . . . .	0.5 c. c.
0.9 per cent. NaCl. solution . . . . .	0.3 »
Broth . . . . .	0.1 »
Bacterial emulsion . . . . .	0.1 »

For the control sowing I used a mixture consisting of 0.9 c. c. of salt water and 0.1 c. c. of bacterial emulsion. This was sown, immediately after being prepared, in 10 c. c. of agar melted, at 50°, in a testing tube; the contents of which were then at once distributed over a Petri dish of the dimensions stated above.

The same was done with the contents of the four tubes no. I, after 3 hours' incubation at 37°.

The result was read after the dishes had been left standing for 24 hours in the thermostat at 37°.

As basis for these experiments I used — as for those of the second series — an 18 hours' broth culture of staphylococcus aureus.

The size of the resulting colonies varied somewhat, according to whether their growth had taken place on the surface or slightly submerged in the thin layer of agar; but in no case did the counting present any difficulty on that score.

In this series, 11 tests were made, altogether; all of them with serum from rabbits. The light-bath consisted, for all of the animals, in irradiation with quartz-light for 30 minutes.

### Third Series of Experiments

#### 12/V. 25. *Exp. I.*

White rabbit (No. 2) exposed to mercury vapour lamp  $\frac{1}{2}$  hour.

Serum sown in melted agar.

Results:	
Number of colonies	
A. Before exposure to m. v. l. . . . .	564
B. $\frac{1}{2}$ hour after exposure . . . . .	552
C. 2 hours after exposure . . . . .	443
D. 3 hours after exposure . . . . .	883
no control sowings.	

#### 14/V. 25. *Exp. II.*

White rabbit (No. 2) exposed to mercury vapour lamp  $\frac{1}{2}$  hour.

Serum sown in melted agar.

Results:	
Number of colonies	
A. Before exposure to m. v. l. . . . .	ca. 3000
B. $\frac{1}{2}$ hour after exposure . . . . .	ca. 3000
C. 2 hours after exposure . . . . .	ca. 2700
D. 3 hours after exposure . . . . .	ca. 3200
no control sowings.	

A bactericidal test (a. m. WULFF) was made at the same time on serum taken before the light treatment:<sup>1</sup>

	Number of colonies	
Tube I . . . . .	—	2
Tube II . . . . .	—	15
Tube III . . . . .	37	ca. 150

### 16/V. 25. *Exp. III.*

White rabbit (No. 2) exposed to mercury vapour lamp  $\frac{1}{2}$  hour.  
Serum sown in melted agar.

	Results: Number of colonies
A. Before exposure to m. v. l. . . . .	200
B. $\frac{1}{2}$ hour after exposure . . . . .	208
C. 2 hours after exposure . . . . .	264
D. 3 hours after exposure . . . . .	83
no control sowing.	

### 30/V. 25. *Exp. IV.*

White rabbit (No. VII) exposed to mercury vapour lamp  $\frac{1}{2}$  hour.  
Serum sown in melted agar.

	Results: Number of colonies
Control sowing . . . . .	232
A. Before exposure to m. v. l. . . . .	421
B. $\frac{1}{2}$ hour after exposure . . . . .	500
C. 2 hours after exposure . . . . .	410
D. 3 hours after exposure . . . . .	469

### 2/VI. 25. *Exp. V.*

White rabbit (No. VII) exposed to mercury vapour lamp  $\frac{1}{2}$  hour.  
Serum sown in melted agar.

	Results: Number of colonies
Control sowing . . . . .	115
A. Before exposure to m. v. l. . . . .	810
B. $\frac{1}{2}$ hour after exposure . . . . .	800
C. 2 hours after exposure . . . . .	870
D. 3 hours after exposure . . . . .	750

A bactericidal test a. m. WULFF was made at the same time on the serum taken before the light treatment:

	Number of colonies	
Tube I . . . . .	—	7
Tube II . . . . .	—	110
Tube III . . . . .	4	300

<sup>1</sup> In all experiments (tests a. m. WULFF) I used the special platinum loop as mentioned in the second series of experiments.

4/VI. 25. *Exp. VI.**White rabbit (No. VII)* exposed to mercury vapour lamp  $\frac{1}{2}$  hour.

Serum sown in melted agar.

## Results:

## Number of colonies

Control sowing . . . . .	396
A. Before exposure to m. v. l. . . . .	270
B. $\frac{1}{2}$ hour after exposure . . . . .	210
C. 2 hours after exposure . . . . .	405
D. 3 hours after exposure . . . . .	510

6/VI. 25. *Exp. VII.**White rabbit (No. VII)* exposed to mercury vapour lamp  $\frac{1}{2}$  hour.

Serum sown in melted agar.

## Results:

## Number of colonies

Control sowings (made in triplo) . . . . .	575, 598, 604
A. Before exposure to m. v. l. . . . .	53
B. $\frac{1}{2}$ hour after exposure . . . . .	38
C. 2 hours after exposure . . . . .	16
D. 3 hours after exposure . . . . .	39

A bactericidal test a. m. WULFF gave this result on the serum taken before the light bath

## Number of colonies

Tube I . . . . .	—	2
Tube II . . . . .	—	10
Tube III . . . . .	20	250

9/VI. 25. *Exp. VIII.**White rabbit (No. VII)* exposed to mercury vapour lamp  $\frac{1}{2}$  hour.

Serum sown in melted agar.

## Results:

## Number of colonies

Control sowing . . . . .	621
A. Before exposure to m. v. l. . . . .	84
B. $\frac{1}{2}$ hour after exposure . . . . .	75
C. 2 hours after exposure . . . . .	36
D. 3 hours after exposure . . . . .	65

A bactericidal test, a. m. WULFF was made contemporaneously in term taken before the light treatment:

## Number of colonies

Tube I . . . . .	—	5
Tube II . . . . .	—	lost
Tube III . . . . .	21	210



11/VI. 25. *Exp. IX.*

*White rabbit* (No. VI) exposed to mercury vapour lamp  $\frac{1}{2}$  hour.  
Serum sown in melted agar.

	Results: Number of colonies
Control sowing . . . . .	1120
A. Before exposure to m. v. l. . . . .	151
B. $\frac{1}{2}$ hour after exposure . . . . .	194
C. 2 hours after exposure . . . . .	198

A bactericidal test (a. m. WULFF) made on serum taken before the light treatment:

	Number of colonies
Tube I . . . . .	— 9
Tube II . . . . .	— 50
Tube III . . . . .	31 ca. 250

16/VI. 25. *Exp. X.*

*White rabbit* (No. VI) exposed to mercury vapour lamp  $\frac{1}{2}$  hour.  
Serum sown in melted agar:

	Results: Number of colonies
Control sowing . . . . .	446, 452
A. Before exposure to m. v. l. . . . .	75
B. $\frac{1}{2}$ hour after exposure . . . . .	30
C. 2 hours after exposure . . . . .	44

A bactericidal test a. m. WULFF on the serum taken before the light bath:

	Number of colonies
Tube I . . . . .	— 8
Tube II . . . . .	— 5
Tube III . . . . .	23 100

18/VI. 25. *Exp. XI.*

*White rabbit* (No. VI) exposed to mercury vapour lamp  $\frac{1}{2}$  hour.  
Serum sown in melted agar:

	Results: Number of colonies
Control sowing . . . . .	960
A. Before exposure to m. v. l. . . . .	233
B. $\frac{1}{2}$ hour after exposure . . . . .	257
C. 2 hours after exposure . . . . .	108
D. 3 hours after exposure . . . . .	175

At the same time was made a bactericidal test a. m. WULFF on serum taken before the light treatment:

	Number of colonies
Tube I . . . . .	— 11
Tube II . . . . .	— 5
Tube III . . . . .	36 ca. 300

**Rabbit II.** — *Experiments I and II* were made with different dilutions of the bacterial emulsion. Both show a slight diminution in the number of colonies 2 hours after the irradiation; but the variation is very slight and can hardly be taken as a positive proof of any increase in the bactericidal power.

Simultaneously with experiment II, a test for bactericidal effect was made with the use of WULFF's method, and in this a moderately bactericidal effect of the serum was observed.

*Experiment III* shows a diminution in the number of colonies 3 hours after the light-bath; but the difference is not enormously great in this case, either.

**Rabbit VII.** — *Experiment IV* shows no noticeable difference in the 4 dishes. By comparison with the control sowing it can be seen that the serum has no bactericidal effect.

*Experiment V*, as exp. IV: no bactericidal effect. — A simultaneous test performed *ad modum* WULFF gave a similar result.

*Experiment VI*: Nothing particular; though perhaps a slight average increase in the bactericidal effect.

*Experiment VII* shows a marked, general increase of the bactericidal effect in all the samples of serum; strongest 2 hours after irradiation.

The control sowing, made in 3 dishes, shows a nice accordance in the number of colonies, which proves the stability of the method.

A test *ad modum* WULFF, carried out at the same time, accords nicely with the principal one. The bactericidal effect, which in the latter is in the proportion of 11 to 1, is in the test *a. m.* WULFF as 10 to 1.

*Experiment VIII*: Here, too, a marked, general bactericidal effect is noticed in all the samples of serum. It is strongest in dish C (2 hours after the irradiation), though not as strong, there, as in the corresponding dish in the previous experiment (VII). Here, also, the observation may possibly be taken to indicate an increase in the bactericidal power.

A test made at the same time with the use of WULFF's method gave exactly the same result as the principal experiment.

**Rabbit VI.** — *Experiment IX*: General bactericidal effect moderately pronounced, but no increase 2 hours after the irradiation. — The result of a WULFF's test concorded with that of the principal one.

*Experiments X and XI* show, for all the samples of serum, a general bactericidal effect similar to the one observed in experiment IX; but, in addition, there is some diminution in the number of colonies after the irradiation. In experiment X, this diminution is particularly noticeable 30 minutes after the irradiation, though also to a certain extent 2 hours after; in experiment XI, the diminution

is most marked 2 hours after. It is possible that this may be due to the effect of the light-bath.

If we look at the results as a whole, it is really only experiment VII and, in a lesser degree, experiments VIII and IX that present features which could, at all, be interpreted as proofs of an increase in bactericidal power occurring 2 hours after the light-bath, such as observed by COLEBROOK, EIDINOW and HILL. And even in these three cases the diminution in the number of colonies is, as also in my previous experiments, not nearly as great as the diminution observed by those authors.

What is evident, however, is the very marked increase in the bactericidal effect of the serum observed in the last two experiments — VII and VIII — with rabbit VII (cf. experiments IV, V and VI with the same animal). Here we see exactly the same thing as with rabbit XVIII in the second series of experiments: namely, that, of the four experiments made, the two last ones showed a considerable increase in the bactericidal power of the serum.

The question which then presents itself is this: When does this increase in the bactericidal power occur, and to what is it due?

**Rabbit XVIII.** — The four experiments were carried out, respectively, on the 7/III, 10/III, 14/III and 17/III. The increase in bactericidal power was observed already in the 3rd experiment, and it manifested itself almost equally strong in the 4th one.

**Rabbit VII.** — With this animal the experiment was repeated 6 times, in all; but the first experiment went wrong after the light-bath had been given and blood samples taken; therefore, only the other 5 have been recorded above. The 6 experiments were made on the 28/V, 30/V, 2/VI, 4/VI, 6/VI and 9/VI. It was not until the 5th experiment (exp. VII) that a very marked increase in the bactericidal power was observed, which then remained almost unchanged in the 6th one also.

We thus notice that in this case the manifestation of increased bactericidal power occurs considerably later than in the case of rabbit XVIII; but this may possibly be explained by the fact that rabbit VII was a full-grown, vigorous animal, while no. XVIII was young and much smaller. At all events, the increase in bactericidal substances does not take place until after some days.

The question now is, whether this more lasting increase in the bactericidal power is the result of the light-baths, or whether it may possibly be due to some other cause.

In order to study this question, an experiment was done with 2 animals (rabbits). One of them was subjected to a 30 minutes' irradiation with quartz-light every second day, 6 times in all. A

sample of its blood had been taken immediately before the first irradiation, and exactly 2 hours after each light-bath 12 c. c. of blood was taken; this quantity corresponding, about, to the aggregate of the 4 samples of blood that had been taken in the course of each of the previous experiments.

At the same times, similar samples of blood were taken from the other animal (the control-animal, to which no light-bath was given).

The serum was centrifuged out on the same day on which the samples of blood were taken, and was placed in the refrigerator, at  $-10^{\circ}$ , until the tests had been completed. By proceeding thus, it becomes possible to examine all the samples of serum at one time, to get the same dilution for the bacterial emulsion, and to insure an absolute uniformity of the nutritive medium.

In all other respects, the technique was exactly similar to the one employed for the 3rd series of experiments.

The result was as follows:

*White rabbit no. A.* exposed to mercury vapour lamp  
each other day  $\frac{1}{2}$  hour.  
Serum sown in melted agar.

Date of the blood-test taken 2 hours after exposure to m. v. l.		Number of colonies
23/VI plate I . . . . .		240
25/VI " II . . . . .		365
27/VI " III . . . . .		380
30/VI " IV . . . . .		330
2 VI " V . . . . .		21
4 VI " VI . . . . .		38
Control sowings: ca. 3200, ca. 3300, ca. 3200.		

Bactericidal test *a. m.* WULFF on the serum taken 23/VI before the rabbit was exposed to m. v. l.

	I		II	
Tube I . . . . .	—	3	—	1
" II . . . . .	—	105	—	30
" III . . . . .	134	ca. 300	162	ca. 400

*Grey rabbit no. B (control).* Serum sown in melted agar.

Date of the blood-test		Number of colonies
23/IV Petri-dish I . . . . .		700
25/IV " II . . . . .		725
27/IV " III . . . . .		332
30/IV " IV . . . . .		88
2/VII " V . . . . .		14
4/VII " VI . . . . .		3

Control sowings: see the previous experiment.

Bactericidal test, *ad modum* WULFF, of the serum taken on 23/VI.

Tube I . . . . .	—	33
" II . . . . .	—	40
" III . . . . .	150	about 300

For both animals, the bactericidal tests made according to WULFF's method agree very nicely with the results of the main tests.

Increase in the bactericidal power is not observed until after some days, and about simultaneously in the control animal and in the irradiated one — in the same manner as was the case with the two other rabbits: XVIII in the 2nd series, and VII in the 3rd series.

There can, therefore, be no doubt whatsoever but that the increase in the bactericidal power is absolutely independent of the light-bath treatment, and that the reason for it is to be found in the blood-letting to which the animals were subjected.

That blood-letting can have a stimulating influence on the formation of other antibodies — such as agglutinins, for instance — is a fact which has already been demonstrated by others (see, for instance, REYMANN: *Om Aareladningens Indflydelse paa Antistofkurven*. Medd. fra Statens Seruminstitut, Bd. IX, 1917). In my experiments, the quantity of blood abstracted was, as already stated, about 12 c.c. every second day, five or six times altogether. With the abstraction of blood in such quantities the increase in bactericidal power has been very considerable. It is possible that the abstraction also of considerably smaller quantities may cause fluctuations in the bactericidal power of the blood; it is, at least, a factor which, for reasons of experimental technique, ought not to be overlooked.

## SUMMARY

The observation by COLEBROOK, EIDINGW and HILL, of a bactericidal optimum in rabbit serum 2 hours after light-bath treatment of the animal, led the author to undertake a triple series of experiments, with certain modifications of technique for each all different of that of the authors abovenamed; but only in a few, isolated cases did the result in any way tend to substantiate the idea of an increase in bactericidal power due to the action of the light. And even in those cases the effect was far less pronounced, and not even constant in the same animal. Therefore the author does not suppose the effect to be absolutely due to the action of the light.

In human serum, no variations in the bactericidal power was observed at all; nor did even repeated light-baths seem to produce any very lasting increase in that power.

In rabbit serum, on the other hand, a very considerable increase of the bactericidal substances was observed to follow repeated experiments with the same animal; but that increase is quite undoubtedly due to the repeated blood-letting only.

A couple of parallel experiments with, respectively, serum and defibrinated blood from the same rabbit, seemed to show that the bactericidal effect of the serum is considerably stronger than that of the blood.

### ZUSAMMENFASSUNG

Die Beobachtung von COLEBROOK, EIDINOW und HILL eines bakteriziden Optimums in Kaninchenserum 2 Stunden nach Bestrahlung mit ultraviolettem Licht liess den Verfasser 3 Serien von Experimenten nach derselben Richtung hier unternehmen.

Nur in wenigen Fällen wurde eine solche Steigerung beobachtet, wenn auch nicht so ausgesprochen wie bei den obengenannten Verfassern; auch war die Zunahme nicht konstant bei demselben Versuchstiere. Nach Ansicht des Verfassers ist sie darum nicht unbedingt einer Wirkung des Lichtes zuzuschreiben.

Der Verfasser hat eine andere Technik als COLEBROOK, EIDINOW und HILL angewendet, und um Versuchsfehler auszuschliessen in den drei Versuchsreihen die Technik jedesmal etwas modifiziert.

Auf das Serum von Menschen wurde kein Einfluss des Lichtes gesehen; selbst nach mehreren Lichtbädern wurde keine Steigerung der Bakterizidität beobachtet.

Im Serum von demselben Kaninchen wurde nach mehreren Experimenten eine recht bedeutende Zunahme der bakteriziden Stoffe gesehen; diese Wirkung ist aber ohne Zweifel den wiederholten Blutentnahmen zuzuschreiben.

Einige Parallelexperimente mit defibriniertem Blut und Serum von denselben Versuchstieren scheinen zu zeigen, dass das Serum eine stärker ausgesprochene Bakterizidität als defibriniertes Blut hat.

### RÉSUMÉ

L'observation de M. M. COLEBROOK, EIDINOW et HILL d'une augmentation passagère des substances bactéricides après le traitement par les rayons ultraviolets fit l'auteur entreprendre 3 séries d'expériences dans le même sens. Il n'a trouvé cette augmentation que dans peu de cas non plus si marquée que chez les auteurs mentionnés ci-dessus; en outre l'accroissement n'a pas été toujours retrouvé chez le même lapin.

Cela donne lieu à penser que ces choses ne sont pas absolument dues aux rayons lumineux. L'auteur a employé une autre technique que celle de COLEBROOK, EIDINOW et HILL. Pour éliminer des fautes dues à la technique il l'a modifiée dans chaque série.

Sur le serum humain il n'a vu aucun effet, même pas après un traitement lumineux repris plusieurs fois.

Dans le serum du lapin il a vu une augmentation considérable des substances bactéricides, mais cette effet a été sûrement due à la perte de sang.

Quelques expériences parallèles avec du sang défibriné et du serum du même lapin, semblent démontrer que l'effet bactéricide du serum est beaucoup plus fort que celui du sang.





## ROENTGENOLOGICAL EXAMINATIONS OF THE STOMACH AFTER RESECTION

by

*Dr. L. Arisz, the Hague*

(Tabulae X—XI)

All examinations on which the following description of the stomach after resection is founded, have been performed on patients, who had been operated by Dr. J. SCHOEMAKER. As form and behaviour of the stomach will depend on the operative method, I first may give a description of Dr. Schoemaker's technic; it is copied from the British Journ. of surg. Vol. X. 1922. p. 144.

The abdomen is opened by a median incision from the sternum to the umbilicus, and the wound is held open by a self-retaining retractor.

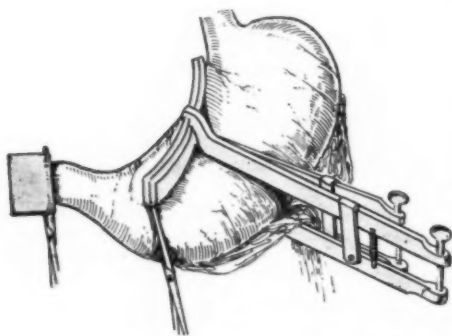


Fig. 1. Resection of the Stomach. SCHOEMAKER's clamp.

The duodenum is lifted up and the attachment of the omenta clamped and cut in sections. Two small clamps are placed on the first part of the duodenum, which is then divided by the knife. The distal end is covered with gauze, whilst the proximal end is protected by a little shield, which fits on to the clamp. The remaining portion of the small omentum is clamped and cut in sections, the coronary artery being

divided in the last. A large pair of special clamps (fig. 1) constructed in two portions is then applied to the body of the stomach; the blades of these clamps, which are about five inches long, are curved in about the same shape as the normal lesser curvature of the stomach. When in position the blades extend from a point on the lesser curvature of the stomach opposite to the coronary artery, at the junction of the

middle and upper thirds of the stomach, to a point about an inch and a half from the greater curvature of the stomach and two inches from the pylorus. The portion of the stomach between the right end of the stomach clamp and the greater curvature is seized by a pair of small forceps like those for colectomy. The stomach is then cut through by a knife applied close to the clamps, large and small. This frees the pylorus and lesser curvature of the stomach, that are removed. The large stomach clamp consists of two portions. After cutting away the pylorus, the distal portion of the clamp is unscrewed and slipped out, thus leaving a compressed edge of stomach wall rather more than one-eighth of an inch in extent projecting from the remaining portion



Fig. 2. Exterior plate of clamp removed, showing narrow strip of serosa secured by a continuous catgut suture.

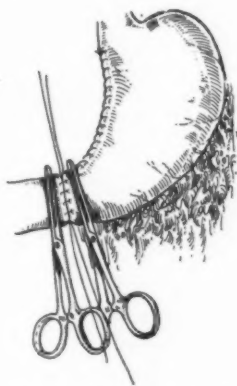


Fig. 3. Union between the stomach and duodenum.

of the clamp (fig. 2). This projecting edge is sewn over by a continuous catgut stitch, and the remaining portion of the clamp is then taken away and a second continuous LEBERT stitch completes the closure of this portion of the gastric wound. The stomach has now been reduced to a more or less tubular structure, the end of which is closed by one small colon clamp. This is brought into apposition with the duodenum, and after two more clamps have been applied proximal to the gastric and distal to the duodenal forceps, an end-to-end junction is effected (fig. 3). The deep surfaces of the viscera are joined by interrupted silk sutures. The terminal clamps are taken off and the whole thickness of the stomach and gut united by a series of interrupted stitches, whilst the anterior layer is completed after the remaining clamps have been removed.

In the roentgenological examination of stomachs operated on this method the following data have been obtained.

*Form:* The form of the gastric shadow after resection depends on the form the stomach had before the operation; this being different in various individuals, the form after resection cannot exactly be the same even when the same operative method always has been followed. In standing patients form and position of the normal stomach depend partly on the tone of the muscular wall and on the weight of its contents, partly on the influence of the other abdominal viscera, especially on the quantity of mesenteric fat. Two extreme types are known, the fishhook-type, in which the stomach is hanging freely on its ligaments and the steerhorntype when it cannot hang, but is supported by the intestine. In both types form and position of the upper part, reaching from behind to the abdominal wall are not very much different, variations being more found in the lower part. As the lower part after resection fails, the general type of the stomach is that of the upper part and therefore it is about the same in all cases.

The stomach keeps an oblique position descending from the cardiac end near the spinal column towards the anterior wall, as the new exit lies in front of the second lumbar vertebra and this must be turned round to reach the duodenum. Three varieties of form are found according to the length of both curvatures left. When only a small part of the stomach has been removed, the remaining part will allow the formation of a type of stomach, resembling the normal fishhook-type: the lesser curvature having an angle, as the descending part bends upwards to the exit, the greater curvature forming a regular shaped, wide curve; the exit then lies higher than the lowest part of both lesser and greater curvature and has an upward direction. (Fig. 4 a.) In other cases the remaining part of the lesser curvature is only sufficient to reach the exit in a straight line, the length of the greater curvature still allowing it to form a wide curve; the exit then is the lowest part of the lesser curvature and is lying above the lowest part of the greater curvature: the exit has a horizontal direction. (Fig. 4 b.) In the third type the lesser curvature runs straight away downwards to the exit and the distal part of the greater curvature has the same direction, is about parallel to it; the exit now is the lowest part of both curvatures and has a downward direction. (Fig. 4 c.) In these three types the remaining part of the gastric walls usually allows a certain degree of distension and the contents are filling the stomach as far as the exit, just as the normal stomach; in very stout patients however the part before the exit is not filled in the ordinary way: we see the filling mass only as broad

stripes, indicating the spaces left between the folds of the mucous membrane: hence we may conclude, that the frontwall of the stomach is drawn against the backwall and that both are pressed against the spinal column; in such cases this part has no more the function of being a reservoir, it is only a tube leading from the filled part of the stomach to the duodenum. (Fig. 4 d.)



Fig. 4 a.



Fig. 4 b.



Fig. 4 c.



Fig. 4 d.

Fig. 4. Different types of the stomach after resection.

The duodenum is modified by the resection, because the first part, the cap, has been removed; the descending part retains the same site, owing to its retroperitoneal position, only the position of the superior part is modified as it is drawn from the upper angle of the descending duodenum straight to the gastric exit. So the site depends slightly on the position of the exit, but great variations do not occur.

*Mobility:* Just as in normal conditions the lower pole of the stomach after resection can be raised, when the abdominal wall is drawn in. When a patient lies down on his right side a certain degree of mobility may be observed: the lesser curvature sinks against the liver, but being fixed at its upper part to the oesophagus it cannot descend very much and remains in front of the spine; the part of the normal stomach that in this position descends before the pylorus and the duodenum, is failing after resection, so the exit can always be seen, being the lowest part of the stomach, only a little more to the right as in the vertical position. The upper part of the duodenum, that is moving rather freely in normal conditions, is now fixed between the exit of the stomach and the retroperitoneal duodenum, thus keeps in the same position, as when the patient is standing.

*Filling:* The stomach after resection fills in the same way as the normal stomach. Usually the opaque meal at first gives a cone-shaped shadow, that keeps this form while enlarging and sinking to the lower pole of the stomach; only in a few cases the first mass, that is taken, immediately sinks to the bottom. The filling continues by gradually broadening both in the upper and lower part. It seems that just as in the normal stomach the empty stomach is small and the frontwall pressed against the backwall; during filling the walls are first separated and then they accommodate to the volume taken. I did not determine how much the stomach after resection can contain; the ordinary meal of 400 cc. is taken without discomfort.

*Contours:* The greater curvature is not modified by the operation and shows the usual smooth contour. Sometimes however the irregular form caused by the folds of the mucous membrane, as in normal stomachs, is seen; it may disappear, when the volume taken increases, but in a few cases it is still present after the whole meal has been drunk.

The lesser curvature has been removed, the upper part excepted; therefore only the upper part has the usual smooth contour; the lower part has been reconstructed by suturing front- and backwall, so it never is smooth, but has numerous folds. In this respect it is different from the normal lesser curvature and the unevenness never proves a pathological condition.

The surface of the mucous membrane cannot be well examined as palpation is not very effective, the chestwall preventing direct pressure. Only in the lower part the walls may be pressed against each other in such a way, that the spaces between the mucous folds remain filled; then stripes are seen, parallel to the greater curvature.

*The exit* is a well defined part; it looks somehow like the normal pyloric sphincter. In standing patients the duodenum is passed

through rather soon and the duodenal contour of the exit cannot be demonstrated very well. In the right lateral and in the prone positions the duodenum is widely filled, and so the exit is well outlined at both gastric and duodenal sides. It is usually a short narrow tube, with a diameter of 2 or 3 mm. connecting the much wider stomach and duodenum. In some patients several exposures were made in order to determine, if the diameter of the exit remains constant; I could state a difference varying from  $\frac{1}{2}$  to 3 mm. in exposures made with  $\frac{1}{2}$  minute's interval (fig. 5 and 6). This observation proves that the exit has the property of narrowing and widening; it is never closed completely.

The diameter of the exit is in the roentgenological examination much less than the surgeon expects it to be. When he examines the communication during operation, it is easily passed by the finger; but when X-rayed it never is found so wide. As we wanted to know, if it would be possible to establish a communication, that could be seen by the roentgenologist as a wide one, an extraordinarily wide communication once was performed, that could be passed by two fingers; yet the X-ray examination four weeks afterwards proved it to be only 3 mm. (Fig. 7.) It therefore appears, that a direct relation between the diameter as determined by surgeon and roentgenologist does not exist.

The exit has the same shape, when it is examined a short time after the operation (4 weeks) and afterwards; several patients were reexamined after periods varying from  $\frac{1}{2}$  to two years; never a change could be observed. Once I examined a patient, on whom three years before resection had been performed; she too had an exit of the same type. (Fig. 8.) I might conclude from these observations, that the exit keeps the form it has in the first examination; it has no tendency for changing afterwards.

The narrow exit might be attributed to the surgical technic used, as both gastric and duodenal walls are bent inwards in making the communication; in the same way in sleeve resection a thickening ring has been described. It is not the result of scarformation, as I could state in the patient, mentioned above, who was examined three years after her operation; she was operated again for another reason and the surgeon could state, that no narrowing of the communication had occurred and that it still could be easily passed by a finger. So the exit is found to be wide always when the patient is in narcosis; when not it is narrow. This statement proves that the form of the exit at least partly results from some muscular action, but it does not indicate that this action depends on muscular elements in the narrowing ring itself. This fact however may be deduced from the



observation of alternative widening and narrowing of the exit, while the adjacent parts of the stomach and the duodenum remain unchanged. Such muscular elements may be as well the gastric muscular layer as the fibres of the muscularis mucosae. As the wall has been bent inwards the number of the muscular fibres in the exit has been increased and so slight changes of tone, that are not noticed in the stomach itself, may become more distinct. The importance of the fibres of the muscularis mucosae has been proved by FORSELL's observations on changes of the folds of the mucous membrane. HELLMER explained in this way variations of the opening in enterostomised stomachs and so it also seems to be possible, that the exit is formed by a tonic contraction of the muscularis mucosae alone and that the variations of the diameter are caused by changes of its tone.

The *duodenum* fills widely in the right lateral and in the prone position; then it shows the typical indentation of the contours due to the mucous folds. When the cap has been removed, the indentation starts at the gastric exit, otherwise a small part has rather smooth contours and the indentation begins a few cm. downwards. The site and direction of the superior part have been changed by the operation as was described above, the descending part retains the same site.

*Peristalsis* is not very vigorous; this may be apprehended as the part of the normal stomach, where peristaltic waves are seen best, has been removed and after resection only that part is left, that also formerly showed but slight movements. Yet in several patients peristaltic waves were observed moving along the greater curvature in a regular way; two or three waves may be seen at the same time. The waves diminish, when approaching the exit and disappear; this causes a marked difference from the normal stomach. After resection the circular muscles do not form a continuous ring, but part of their length has been removed, this part gradually increasing towards the exit. The same relative shortening by a contraction must therefore give a smaller absolute shortening effect, consequently less deep waves. So all waves must diminish in the part where the resection has been made.

The lesser curvature too shows sometimes peristaltic waves, not only in the part that was left, but also in the reconstructed part; the thickening in the line of suture seems to be no impediment. When a wave moves along both curvatures, we often see them touch in such a way that a part of the stomach is segmented resembling the normal antrum; however it behaves different, as the waves soon loose their contact and the walls flatten out again; a complete contraction of the part before the exit is never seen.

*Antiperistalsis:* The unusual phenomenon of antiperistalsis was seen in a patient, who was examined four weeks after the resection. Normal peristaltic waves were not observed, but half an hour after he had taken the opaque meal waves started at the greater curvature close to the exit and travelled upwards; the lesser curvature did not move. As this stomach in other respect did not give abnormalities and the patient felt quite well, I think, we are justified to exclude any pathology; this observation thus proves that antiperistalsis may occur without an ulcer or tumour. A similar observation was made in another patient who showed antiperistaltic waves immediately after the stomach had been filled: here they were best seen at the greater curvature, but moved also along the lower part of the reconstructed lesser curvature. As most examiners have described that antiperistalsis generally denotes the existence of organic disease, we may suppose that a little scar in the sutured parts gives a stimulus for antiperistalsis. A passive distension of the stomach caused by defective motility cannot be the cause, as the discharge was not interfered with; even during the antiperistaltic movements intermittent passage into the duodenum went on.

*Secretion:* When a stomach contains some secretion at the time, when the opaque meal is taken, during the first minute they are mixed up, but they separate rather soon into two layers; so after one or two minutes the intermediate layer allows an estimation of the amount of secretion in fasting condition. Sometimes in this way absence of secretion was stated, sometimes an intermediate layer of two cm. was seen. When the intermediate layer increases during the examination this may be due partly to the forming of secretion, partly to sedimenting of the bariumsulfate. As I was told by the gastroenterologist, the secretion of the stomach after resection possesses an acidity slightly less than the normal stomachs; so a digestion of the flour used in the preparation of the opaque meal may take place and allow the bariumsulfate to sink in the usual way. An accurate estimation of the amount of secretion therefore cannot be obtained. I stated e. g. after 5 minutes an intermediate layer of 2 cm., after 10 minutes of 3 cm., after  $\frac{1}{2}$  hour of 7 cm. When an opaque meal a mixture of meat and potatoes with bariumsulfate is given the intermediate layer is less deep; I found e. g. after  $\frac{1}{2}$  hour 3 cm.

*Motility:* An investigation in the motility must answer two different questions: first how much time does the stomach want to get empty, secondly can the stomach discharge its contents completely.

The discharge of the gastric contents starts as soon as they have reached the exit. In standing patients sometimes it is very fast, as may be found in enterostomised stomachs and even in normal

stomachs, when the pyloric sphincter is opened; usually it is rather calm, continuous or intermittent. The duodenum is not widely filled, often less than usually seen in normal conditions; a rapid distension of the small intestine is a rare appearance. In the right lateral and prone positions the discharge seems to be a little faster than in standing, the duodenum is more filled and gastric contents seem to diminish sooner. Pressure on the stomach by palpation and exaggeration of the abdominal pressure, when the abdominal wall is drawn in, may accelerate the discharge a little.

The motive power for the discharge must in the first place be the hydrostatic pressure. When the stomach is filled with a suspension of bariumsulfate in limonade the rate of the discharge remains constant during the first time, as may be expected, because the depth of the fluid column above the level of the exit remains the same during a considerable time and only gastric diameter accommodates to the diminishing contents. The narrow exit may be a cause of retardation and when in the part before the exit the walls are pressed against each other the folds of the mucous membrane also must give some resistance. In the right lateral position the hydrostatic pressure in the same way may be the motive power. Perhaps peristaltic waves may support the discharge, but their effect seems to be less than in the normal stomach. The hydrostatic pressure can only cause the discharge of the part of the contents, that is above the level of the exit; usually, also in those stomachs, where the greater curvature is hanging in a wide curve below the level of the exit, gastric contents are moved into the intestine, so the hydrostatic pressure cannot be the only force, but changes of tone must have an important role.

When the opaque meal is not a liquid, but consists of minced meat and potatoes mixed up with bariumsulfate by means of gravy, the discharge into the duodenum is slower, but not different; it also starts as soon as the exit is reached and goes on in an intermittent way; peristaltic waves seem to have more influence, but even without peristalsis the discharge goes on.

The time necessary for gastric clearance depends on the meal given. The bariumsulfate given in a thin liquid limonade of 400 ccm. is for the larger part discharged in half an hour; this is a rather long time, when one considers that a stomach after resection is a sac with an opening at the lower end that may be compared with a non-operated stomach, with a carcinomatous rigid open pylorus, that will empty within a few minutes. Bariumsulfate given with meat and potatoes leaves the stomach in about three hours. This rather slow clearance may be taken as a condition favourable for the

mixing of food and secretion in such a way that a preliminary digestion may occur.

In order to answer the question, if the stomach after resection possesses the faculty of discharging all contents into the duodenum, special attention was paid to small rests at an examination 6 hours after the first one. Between both examinations patients were not allowed to eat or drink anything. In the larger part of all cases a few barium rests remained. (Fig. 9.) As the principal quantity was discharged in a much shorter time these small rests cannot be the result of a mechanical impediment; they must be explained as the result of defective function of the gastric muscular wall. Sometimes the rest has the shape of a curve along the greater curvature, sometimes of a segment with a level, indicating that an intermediate layer must be present; sometimes stripes directed towards the exit indicate, that a small amount of barium is retaining between the folds of the mucous membrane. Similar rests are found in examinations of not-operated stomachs, when something pathological in duodenal or gallbladder region is found; therefore such rests do not necessarily prove that an organic change of the gastric muscles

exists, a functional impairment however seems to be a necessary supposition. It is no wonder that the function of the gastric muscles, even if they are not diseased, is interfered with by the permanent injury caused by the resection; when the part of the stomach before the exit cannot completely move its contents as the normal stomach does, we may ascribe it to the less suitable course of the muscular fibres. The incomplete clearance does not produce any symptoms perceptible for the patient himself.

**Conclusion:** The examination of the stomach after resection in patients who have been cured by this operation in a quite satisfactory way, shows that form and position of the stomach, as well as its function, usually are about the same, when the operation has been performed by the surgeon on a definite scheme. The muscular wall is somehow damaged, as it has lost the property of discharging its contents completely. This small retention does not need to be looked at as a serious factor for the formation of a new ulcer, as the



Fig. 9 a.

Fig. 9 b.

Fig. 9. Two types of the residue in the stomach after resection at an examination six hours after filling.

favourite site, the lesser curvature, has been removed. Functional disorders as seen after other gastric operations, in which the ulcer is left (see preceding paper), never can occur. The small intestine is not set the task of taking in a few minutes most of the gastric fluid contents but they are discharged after they have been in contact with the gastric juices during a sufficient time for a preliminary digestion.

When patients who are not cured by the resection are examined, the stomach is not found different. In these patients the operation had been performed on account of a red stomach, whilst an ulcer had not been found. Here the real cause of the patients' complaints perhaps was not recognised and thus not eliminated by operation. I saw some patients, who had been cured quite a long time and then once more complaints started. Never I succeeded in showing some pathology about the stomach.

After the resection nothing is left in the stomach, that reminds one of the ulcer removed. This may be easily understood, when the site of the ulcer was near to the pylorus, but in ulcers of the upper part of the lesser curvature the larger part of the circular muscles opposite to the ulcer are left. In a case, where before the operation a deep circular spasm opposite the ulcer existed, no irregular form after resection was seen; apparently the cause of the spasm had disappeared and the muscular fibres had not been damaged by the period of tonic spasm, that had lasted for a considerable time.

**SUMMARY.** Analysis has been given of the stomach after resection. When the operation has been performed in a systematic way as Dr. J. SCHOEMAKER uses to do it always identic results are obtained. Form, mobility, filling, contours, exit, peristalsis and motility have been studied; special attention was paid to the new made exit, that has the form of the normal pyloric sphincter and functions in about the same way.

**ZUSAMMENFASSUNG.** Verfasser gibt eine Analyse der Verhältnisse beim Ventrikel nach Vornahme von Resektion. Wenn die Operation systematisch in der Weise ausgeführt worden ist, wie Dr. J. SCHOEMAKER es zu tun pflegt, werden immer identische Resultate erhalten. Es wurden Form, Mobilität, Füllung, Konturen, Ausflussöffnung, Peristaltik und Motilität studiert und besondere Aufmerksamkeit wurde der neuangelegten Öffnung gewidmet, welche die Form des normalen Pylorussphinkters hat und ungefähr in derselben Weise funktioniert.

**RÉSUMÉ.** L'auteur communique une analyse de l'état de l'estomac après résection. Lorsque l'opération a été faite suivant un procédé systématique, comme le Dr J. SCHOEMAKER a coutume de le faire, les résultats sont toujours identiques. L'auteur a étudié la forme, la mobilité, la réplétion, les contours, l'évacuation, le péristaltisme et la motilité de l'estomac; il s'est particulièrement attaché à l'étude du nouvel orifice qui affecte la forme du sphincter pylorique normal et a des fonctions analogues.





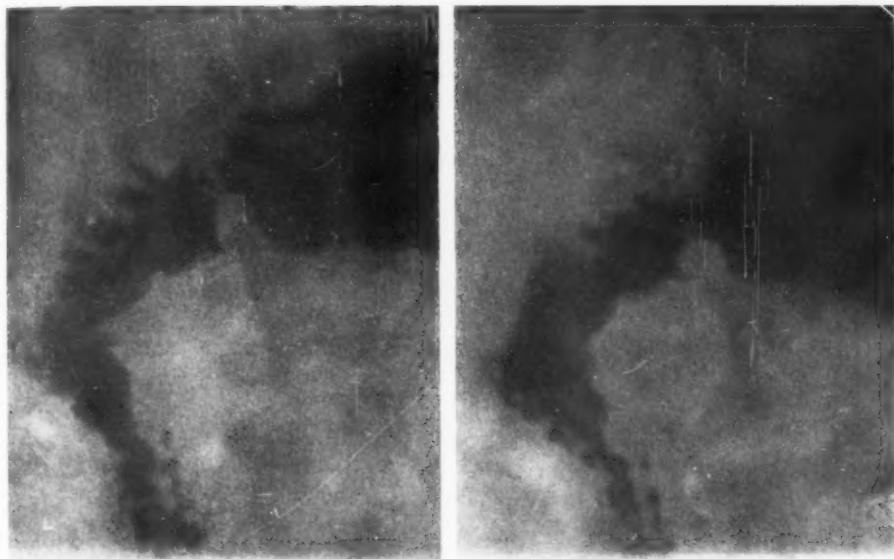


Fig. 5. Exit of the stomach after resection; two exposures made in the same patient with  $\frac{1}{2}$  minute's interval, showing variation of diameter. Prone position.

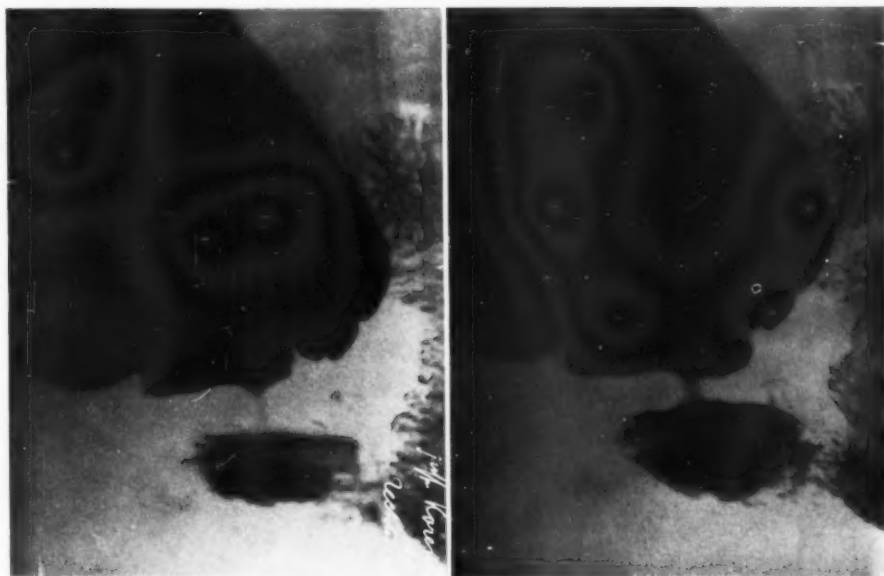


Fig. 6. Exit of the stomach after resection; two exposures made in an other patient with  $\frac{1}{2}$  minute's interval, showing variation of diameter. Right lateral position.







Fig. 7. Exit of a stomach after resection, that has been made so wide, that during the operation two fingers could pass; X-ray examination demonstrates an exit of only 3 mm diameter. Vertical position.



Fig. 8. Exit of a stomach three years after resection. Vertical position.



## A CONTRIBUTION TO THE DIAGNOSIS IN DISEASES OF THE VERTEBRAL COLUMN

by

*Chr. M. F. Sinding-Larsen, Oslo*<sup>1</sup>

(Tabulae XII—XIV)

Every day, as our diagnostic equipment is getting more and more perfected, our work, as regards exact recognition of the various diseases, is, of course, in many ways getting easier, too. But it is not only getting easier. In the stronger light, that which we were already able to discern, stands out more sharply; but back of the old features, and beside them, we glimpse new ones, which formerly avoided our scrutiny, — and with them new questions arise and demand to be answered.

The perfectionation of the roentgen diagnosis — through the introduction of better lamps and shutters — exemplifies the truth of this, as the following observations will show.

### **I. Horizontal Fissures, Real (Traumatic) and Apparent, in the Corpora Vertebrarum**

In the 1st volume of the *«Chirurgie Réparatrice et Orthopédique»* (Masson, Paris 1920), in the chapter on injuries of the spine, FRELICH, of Nancy, describes a number of cases of *spondylite traumatique* (KÜMMELL's spondylitis) the radiographs of which, both front- and side-views, in a couple of cases show the presence of horizontal fissures through the middle of several corpora, with or without deformation of the latter — Fig. 1, a and b.

According to FRELICH, the fissures — some of which are seen only in the spongiosa, while others go through the anterior part of the corticalis as well — are due to numerous trabecular fractures, which the trauma has produced in the spongiosa, either with or without causing any break in the corticalis at the same time.

<sup>1</sup> A paper read at the Meeting of the Oslo Surgical Society, Oct. 12th, 1925.

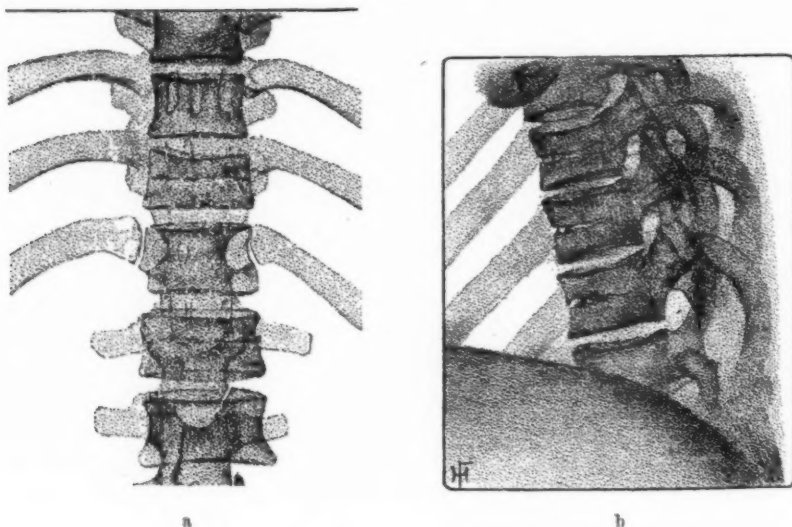


Fig. 1. From FRÆLICH »Chir. rép. et orthopédique».

That this is not always the origin of the »fissuræ» that can be found in the body of the vertebræ, may be seen from the following observations.

The first case — a »KÜMMELL» with wedge-shaped deformation of one corpus and fissures in a couple of others — came under treatment, in December 1924, at the Surgical Dep't A of the Rikshospitalet; and it is to the Head Surgeon of that Dep't, Professor JOHAN NICOLAYSEN, that I am indebted for the permission to report it here.

*Case I.* T. J., a telephone workman, aged 24. On Dec. 5th, 1924, he was struck in the back by a falling telephone pole. As he was in a stooping position at the moment, it was the thoracolumbar portion of his back that received the brunt of the impact. He did not faint, nor even fall, but was able to walk to his home, a quarter of a mile away. From there, he was immediately brought to the Rikshospitalet. When he came under observation there, he had pains in his back, but he was able to stand. No paresis; patellar reflexes strong. No radiating pains. Roentgen-examination disclosed (Fig. 2) a wedge-shaped compression-fracture and a short horizontal fissure in the body of the 11th thoracic vertebra, and a horizontal fissure in the body of each of the two following (the 10th and 9th). Two of the fissures, at least, extended through the corticalis also; but all of them were visible only in the lateral views, none in the A. P. In accordance with the opinion of FRÆLICH, which I have quoted above, I regarded their traumatic origin as

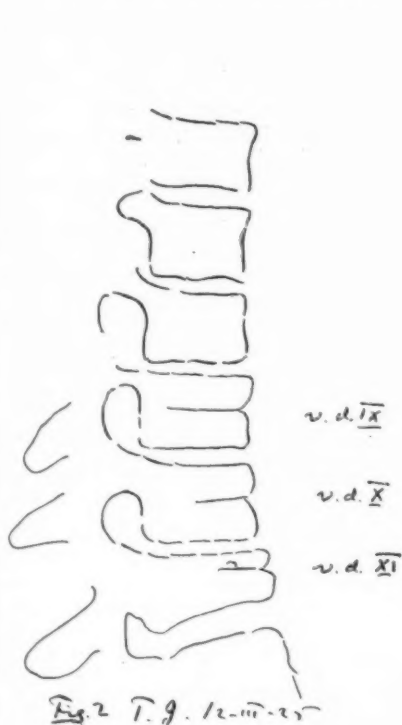


Fig. 2. Case I. T. J. Dec. 1924. Rikshospitalet. Kir. A. Professor J. NICOLAYSEN.



Fig. 3. Case II. H. M. July 1925. Author's observation.

beyond doubt; but then . . . on July 22th, of the present year, there came to me for after-examination:

Case II. H. M., a man 22 years old, whom, since July 1910, I had treated for a lumbar spinal caries with psoas-abscess. The treatment had consisted, first in plaster-bed and punctures, then — from May, 1911 — in his wearing celluloid corsets for some years. Afterwards, he had of his own volition — and though it was quite unnecessary — gone on using these corsets, and he now came — six feet tall, healthy and strong; but with the remnants of the last one still around his waist — to call on his old doctor. He had been working — first at school, later in an office — ever since 1911. He had never suffered any kind of hurt to his back. The lumbar spine was somewhat stiff, but there was no gibbus. The roentgen picture showed (Fig. 3) a perfect non angular fusion between the bodies and articular processes of the 3rd and 4th lumbar vertebrae; but it also showed, in the body of the 10th and 11th thoracic vertebrae — and possibly in the body of the 12th one, as well — a horizontal fissure, which, however, was limited to the spongiosa, and



did not extend through the corticalis; and which — exactly as in Obs. I — was visible only in the lateral view, but not in the anteroposterior one.

In this case the fissures were not due to a trauma. Were they traumatic, then, in the former case? And, if not — what could those fissures mean?

A possible aid to the explanation I had got a little earlier last summer, during a visit I had from Dr. ROBERT B. OSGOOD of Harvard, Boston, in the course of which we discussed the question of Pott's disease and went over the roentgen pictures of some cases which I have under treatment. Among those cases was:

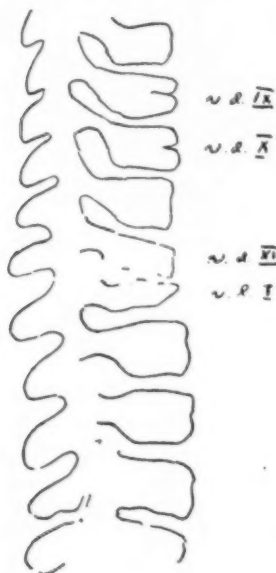


Fig. 4 K. H. 20.10.25

Fig. 4. Case III. K. H. April 1925.  
Author's observation.

*Case III.* K. H., a girl about 6 years old, whom I had, for 15 months, had lying in plaster-bed, in a paraparetic condition, for caries in the 12th thoracic and the 1st lumbar vertebrae. In one of the roentgen pictures of this case Dr. Osgood showed me — what I had overlooked myself — distinct horizontal clefts, or fissures, in the 9th and 10th thoracic vertebrae, with opening toward the front through the corticalis; but — just as in the two cases already described — visible only in the lateral views, fig. 4.

In this case there could be absolutely no question of a trauma; and Dr. Osgood, who had seen similar cases before, told me that such fissures have already been the subject of description, and have been explained as remnants of the channels transmitting the nutrient vessels. — [A similar explanation of frontally opening fissures, said to be frequently (normally?) observed in the vertebral column of the child, is — I have later been told — given by Dr. HAHN, in the *Fortschr. a. d. G. d. Röntgenstrahlen*, vol. XXIX, 2, p. 211; and by Dr. DELAHAYE (BERCK), in the *Journal de Radiologie*, vol. VIII, 1924.]

It seems to me very probable that the »fissuræ» in my 2nd case — the non-traumatic one — and at least possible that those in the 1st (the traumatic one) — are traces, remaining since childhood, of just such »clefts» as the pictures showed so clearly in the 3rd case, — that of the little girl. In all those three cases of mine the fissures are seen only in the lateral views; while, in the cases described by FRÖLICH, the fissures are seen both from the side and in the anteroposterior views. This supports the explanation of the non-traumatic »fissuræ» as being — also in the case of adult individuals — profile-projections of the anteroposteriorly orientated nutrient vessels, or rather of their — perhaps abnormally large — foramina and channels. It is evident that, in the front pro-

jection, the shadows of the latter cannot possibly come to appear as an uninterrupted, transversal, horizontal furrow; while, on the other hand, an actual *solutio continui* existing through the horizontal plan of the body of a vertebra would probably stand out equally well in either projection.

To test the correctness of this reasoning I have made the following simple experiment: At a post mortem I excised 2 lumbar vertebræ of an adult human body. In one of them the corpus was with a drill horizontally perforated in the sagittal plane. The other was with a saw cut horizontally through the middle of the corpus. Both of them were then roentgen-photographed en profile and en face. The pictures confirm the reasoning, which they were to test (Tab. XII Fig. 5, a and b).

At all events, it will be well to remember that »fissuræ» disclosed by the roentgen picture in the body of one vertebra, or more, of a grown person who has received an injury, need not necessarily be related to that injury, but may be due to some pre-existing »*lusus naturæ*».

After this had been written and read, I have seen two more cases of apparent fissures in the vertebral column, one in an adult, the other in a child; the first one through the courtesy of professor NICOLAYSEN.

*Case IV.* B. H., a man 23 years old, was admitted to Surgical Dep't A of the Rikshospitalet, on Oct. 29th, 1925, as suffering from pains in his back, which had been troubling him for a couple of years. Seven years ago he had been badly hurt by falling down a lift-shaft, but had got well quickly and had remained in good health for five years after. A roentgen picture, in side view, of his vertebral column now shows (Fig. 6) the body of the 11th thoracic vertebra slightly wedge-shaped (consolidated »KÜMMELL»?). In the body of the 10th thoracic vertebra there is a distinct »fissure», but opening toward the back. Just as in the three foregoing cases, this fissure is not seen in the a. p. picture. It seems to me entirely unreasonable to connect it with the trauma of 7 years ago. A traumatic *solutio continui* produced so long ago would no doubt have closed up long before this. Also in this case the fissure must certainly have its origin in the nutrient vessels; and the larger opening toward the back seems to accord very well with what LEXER tells us: that the larger nutrient vessels enter the body of the vertebra from the back, and not from the front.

*Case V.* K. N., a boy 6½ years old, I have treated for dorso-lumbar caries with gibbus and psoas-abscess since Sept. 1921, first for about a year with plaster-bed and (14) punctures, then, after a fistula-phase, overcome by aseptic dressing without any sort of light-treatment, with corsets. From Sept. 1922 he has been allowed to move about. On Dec. 2, 1925 his mother asked if he might drop the leather corset, which he was still wearing, but which he had outgrown. The boy was flourishing, his back showed no trace of gibbus. His roentgen pictures show (Fig. 7) a nearly complete fusion of vert.

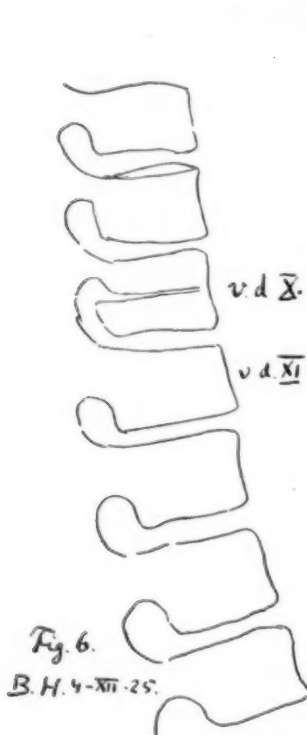


Fig. 6. Case IV. B. H. Oct. 1925.  
Rikshospitalet. Kir. Avd. A.  
Professor J. NICOLAYSEN.

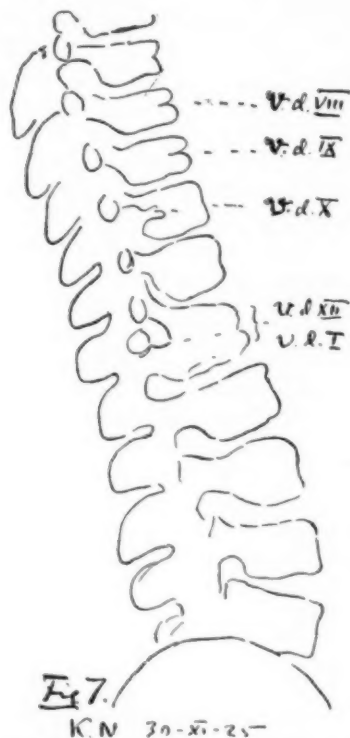


Fig. 7. Case V. K. N. Dec. 1925.  
Author's observation.

dors. XII and vert. lumb. I, no anteropost. angle and only a slight and well compensated scoliosis. The profile R. p. of his spine shows moreover a posterior horizontal fissure in corpus vert. dors. X, and distinct anterior fissures in corp. vert. dors. IX and VIII. (As to his putting off his corset I think he ought to wear a Hessing-corset for  $1\frac{1}{2}$  year: but then I should think he may safely be released, — no need previously performing neither Albee's nor Hibbs' operation!) [The two new cases need no commentary].

## II. Luetic Spondylitis, Simulating Spinal Caries with Sessile Abscess

When roentgen pictures of pathological conditions in the vertebral column show alterations in the body of one or more vertebrae without it being possible to determine the exact nature of the pathological process, an abscess-shadow surrounding the diseased area — a

»sessile» abscess — is generally taken as proof of the process being a tuberculous one. As a rule, such tuberculous abscesses leave, in the tissues in which they were located, a calcareous or putty-like deposit which, years after the abscess has been healed, can give, in the roentgen pictures, a shadow just as strong as the one produced by the abscess itself in its florid state; the reason being, of course, that the pus is not discharged but dries up *in situ quo*.

The following case shows that a shadow, as of an abscess, can be found also around luetic foci in the vertebral column; but that specific treatment will, in rather short time, cause a shadow of that kind to disappear completely, or almost so.

*Case VI.* N. N., an army officer, aged 31. As to previous illnesses, he stated that he had had none except a pleurisy and a gonorrhoea. In 1922, he got »lumbago», without any trauma preceding, and was treated — by various specialists — with all sorts of physical therapy, plus divers injections. Had never been roentgen-photographed. His condition had become steadily worse. On May 1st, 1924, he was sent to me by Dr. V. MAGNUS, who suspected a case of spondylitis.

I found him pale, sick-looking and worried; he walked with a stoop. He complained of incessant pains during the day, and especially at night. The lumbar spine was rigid; he was unable to bend down and get back into an erect position without »climbing». The patellar reflexes were active; there was a slight ankle-clonus. No pelvic abscess. *Roentgen-examination* showed: irregular outlines, heterogeneous structure of the 11th and 12th thoracic vertebrae, and uneven distribution of their calcareous substance, besides a sessile abscess surrounding those two vertebrae and extending downwards past the 1st lumbar, upwards past the 10th thoracic one, Tab. XII Fig. 8.

Pains so violent as in the present case are not usually known in tuberculosis, but only in lues or in the case of malignant tumours. The roentgen picture of the diseased corpora led me, in this case, to think of lues, in spite of the sessile abscess. Pirquet turned out negative (?); but Wassermann gave + +.

The patient was put in plaster-bed, was given potassium iodide and mercury, and the pains very shortly disappeared. In August, 1924, he could leave the plaster-bed, was fitted with a corset, and was given a series of salvarsan injections. Since January, 1925, he has been perfectly well.

A roentgen picture taken in July 1925, shows (Tab. XII Fig. 9) exostoses on and bony bridges between the bodies of the 10th, 11th and 12th thoracic vertebrae. The calcareous structure of the 11th and 12th ones is now much more homogeneous, and the sessile abscess has almost disappeared.

We thus see that »sessile abscesses» can be found also in connection with lues of the vertebral column; but, in contrast to the tuberculous abscess, they disappear very quickly, — also in the roentgen pictures.

### III. Rapidly Developing Spondylitis Ankylopoetica

*Case VII.* P. P., a merchant, aged 31. A sportsman and hunter, he had always been in excellent health until, in 1918, he got »lumbago» while out shooting. Since that time he had had yearly attacks of »lumbago» and »ischias», for which he had been treated with diathermy, irradiation and

massage. On July 17th, 1923, he consulted me for pains and stiffness in the back. On examination, I found the lumbar spine rigid, without any gibbus. Movements, or any kind of impact, caused pains. There was no pelvic abscess. Patellar reflexes weak. Lasègue negative. Partial inhibition of the extension in the hips. The roentgen pictures looked at first sight normal; but on closer examination they showed disappearance of the »joint fissures» between (i. e. the articular cartilages of) the lumbar articular processes, which, moreover, looked abnormally pointed (Tab. XIII Fig. 10).

I diagnosed the case as one of rheumatic spondylarthritis (deformans?). I prescribed a Hessing's corset, and lost sight of him for about two years.

In May, 1925, he called on me again. He was still using the corset, which had kept him free from pains to such an extent that he had been able to go out ski'ing and shooting. The lumbar column was still rigid; but there was no gibbus, and he had no pains.

Roentgen-examination showed an already very far advanced spondylitis ankylopoetica, with bridges between the bodies of the lower thoracic and the first 4 lumbar vertebrae, and ankylosis between their articular processes (Tab. XIII Fig. 11).



Fig. 12. (See Appendix, page 215)

The pathological alterations in the roentgen pictures taken in 1923 were quite as easily overlooked as it was easy to observe those in the pictures of 1925 and the case shows how very important it is, in examining radiographs of »lumbago»-patients, to pay particular attention to the articular processes. Small, and often entirely overlooked, alterations in the latter may, in many cases, serve to indicate the approach of some serious pathological development, and may thus contain a warning for the physician to be sufficiently reserved in his prognosis.

Of the case here described it can only be said that it is, of course, now beyond a cure; and there is hardly any treatment that could have made things otherwise. But at least the patient has been relieved of the pains that formerly made his affection unbearable.

## Appendix

One more case of apparent fissures in corpora vertebrarum, which I have lately seen, I think worth publishing:

H. H., librarian, aged 31, had since the age of 16—17 years a »Lehrlings-kyfoskopiose» (SCHANZ-ELSNER) contracted by carrying heavy burdens of wood on his shoulder. Now (January 1926) he complained of a feeling of pressure in his back, which presented a moderate kyfoskopiosis in the lower dorsal part of his spine (vert. dors. VI—X).

The profile radiogramme shows, besides the kyfosis and a beginning spondylitis deformans, very clear »fissures» in the corpora vert. dors. VIII, IX, X — all of them opening backwards in the canalis spinalis. (Fig. 12 and Tab. XIV Fig. 13).

## SUMMARY

The writer reports:

I. Two cases of traumatic spondylitis and three cases of spinal caries, in all of which the roentgenograms show *horizontal fissures through the middle of the corpora of one or more vertebrae, but only in the profile projection* contrary to what is seen in the roentgenograms of some cases of traumatic spondylitis reported by FRÉLICH, with fissures also in the en face projection. The writer thinks that his profile fissures are only apparent, representing the channels of *vasa nutritia*, or (in the adults) their traces, whereas the en face fissures in FRÉLICH's cases (Fig. 1 a) are real *solutiones continui*. This opinion the writer confirms by references to the radiological literature and a simple experiment (see Tab. XII Fig. 5 a & b and the relevant part of the text). *His (the writer's) cases show that not all profile »fissures» seen in corpora vertebrarum of traumatic cases need be real and traumatic.*

II. A case of *syphilis of the spine* with, on the roentgenogram (Tab. XII Fig. 8), a shadow quite like the shadows of »sessile» tuberculous abscesses. After specific treatment the luetic »abscess» disappeared in a much shorter time than sessile tuberculous abscesses are wont to do (Tab. XII Fig. 9).

III. A case of »lumbago» which, by reason of some rather slight and at first sight overlooked alterations of the processus articulares in the roentgenogram, was diagnosed as spondylarthritis lumbalis (Tab. XIII Fig. 10). After a couple of years the case had developed into a very grave form of *spondylitis ankylopoetica* (Tab. XIII Fig. 11). *The case shows the importance for the prognosis of closely scrutinising the processus articulares in the roentgenograms of cases of lumbago.*

## ZUSAMMENFASSUNG

Verf. berichtet über

I. 2 Fälle von traumatischer Spondylitis und 3 Fälle von Wirbelkaries, deren Röntgenogramme sämtlich *horizontale Fissuren durch die Mitte eines oder mehrerer Wirbelkörper zeigten, aber nur bei Profilprojektion*, im Gegensatz also zu dem Verhalten bei den Röntgenogrammen einiger von FRÉLICH publizierter Fälle traumatischer Spondylitis, bei welchen auch in der Vorderansicht Fissuren zu sehen sind. Verf. ist der Ansicht, dass die Profilfissuren seiner eigenen Fälle nur scheinbar sind und die Kanäle der *Vasa nutritia* oder (bei den Erwachsenen) ihre Spuren repräsentieren, während die enface-Fissuren der Fälle FRÉLICH's (Fig. 1 a) wirkliche *solutiones continui* sind. Diese Ansicht



wird vom Verf. durch Referate aus der radiologischen Literatur und durch ein einfaches Experiment bekräftigt (siehe Tab. XII Fig. 5, a und b und den Text der Arbeit). *Die Fälle des Verf. zeigen, dass nicht alles, was in den Wirbelkörpern traumatischer Fälle als Profil-»Fissuren« erscheint, wirkliche und traumatische Fissuren sein müssen.*

II. 1 Fall von *Syphilis der Wirbelsäule* mit einem Schatten auf dem Röntgenogramm (Tab. XII Fig. 8), der ganz dem Schatten »sessiler« tuberkulöser Abszesse gleicht. Nach spezifischer Behandlung verschwand derluetische »Abszess« in weit kürzerer Zeit, als es bei den Abszessen der sessilen Tuberkulose der Fall zu sein pflegt (Tab. XII Fig. 9).

III. Ein Fall von »Lumbago«, der auf Grund ziemlich leichter und auf den ersten Blick übersehener Veränderungen an den Processus articulares im Röntgenogramm als Spondylarthritis lumbalis diagnostiziert wurde (Tab. XIII Fig. 10). In nur 2 Jahren entwickelte sich der Fall zu einer sehr schweren Form von Spondylitis ankylopoetica (Tab. XIII Fig. 11). *Der Fall zeigt die prognostische Wichtigkeit genauer Besichtigung der Processus articulares auf den Röntgenogrammen von Lumbagofällen.*

## RÉSUMÉ

L'auteur communique:

I. Deux cas de spondylite traumatique et trois cas de carie vertébrale dans chacun desquels la röntgenogramme montrait des fissures horizontales à travers le corps d'une ou plusieurs vertèbres, fissures visibles seulement en projection de profil, contrairement aux indications données par les röntgenogrammes dans certains cas de spondylite traumatique communiqués par FROELICH, où les fissures s'observaient également en projection de face. L'auteur pense que les fissures visibles de profil seulement représentent les canaux des vaisseaux nourriciers, ou, chez l'adulte, les vestiges de ces canaux, tandis que les fissures de face signalées dans les cas de FROELICH (Fig. 1 a) constituent de véritables solutions de continuité. Cette opinion de l'auteur s'appuie sur les données de la littérature radiologique et sur une simple expérience (Tab. XII Fig. 5 a & b et le texte). *Les cas communiqués par l'auteur montrent que toutes les »fissures« de profil observées dans les cas de traumatisme au niveau des corps vertébraux ne sont pas nécessairement de véritables solutions de continuité d'origine traumatique.*

II. Un cas de syphilis de la colonne vertébrale dans lequel la radiographie montre une ombre très analogue aux ombres des abcès tuberculeux »sessiles«. A la suite du traitement spécifique, cet »abcès« syphilitique se résorba dans un délai notablement plus court qu'il n'est de règle pour les abcès tuberculeux sessiles (Tab. XII Fig. 8, 9).

III. Un cas de »lumbago«, dans lequel, par suite de la présence sur la radiographie d'altérations légères et ayant échappé à un premier examen des processus articulaires, on avait porté le diagnostic de spondylo-arthrite lombaire (Tab. XIII Fig. 10). Au bout de deux ans environ, l'affection a évolué en une forme très grave de spondylite ankylosante (Tab. XIII Fig. 11). *Ce cas prouve la nécessité, au point de vue du pronostic d'un examen très serré des surfaces articulaires dans les radiographies prises dans des cas de lumbago.*





Fig. 5 a.



Fig. 5 b.



Fig. 8. Case VI. N. N. May 1924.  
Author's observation.



Fig. 9. Case VI. N. N. July 1925.  
Author's observation.



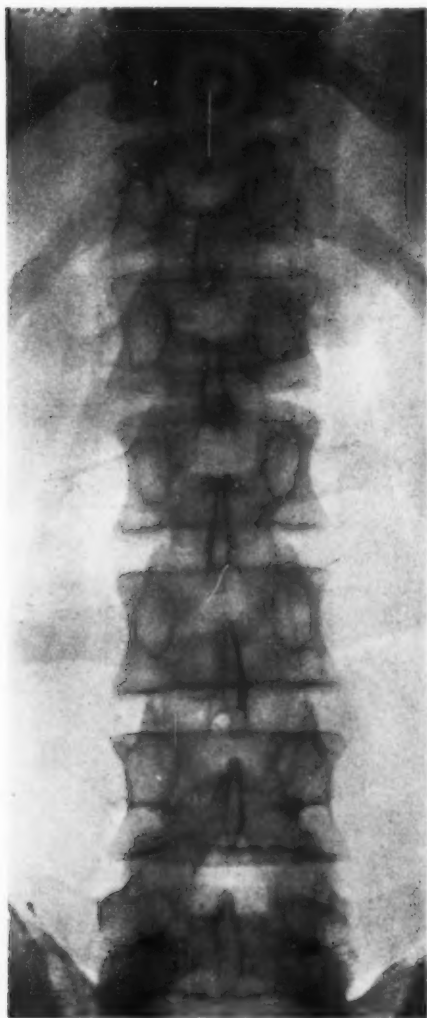


Fig. 10. *Case VII.* P. P. July 1923.  
Author's observation.

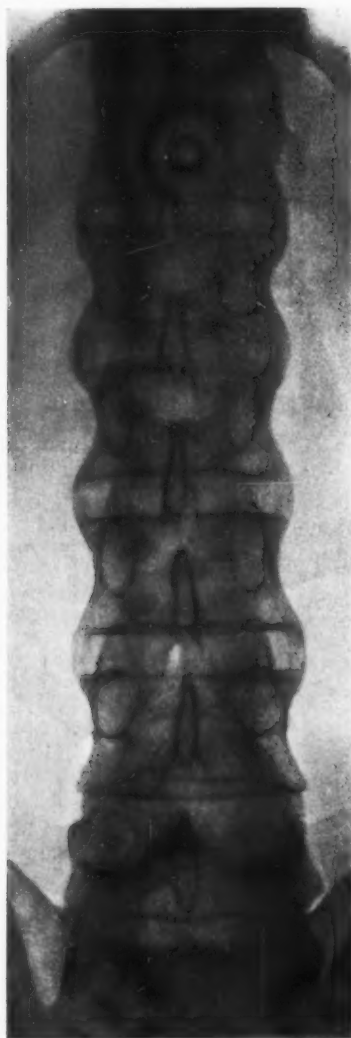


Fig. 11. *Case VII.* P. P. May 1925.  
Author's observation.





Fig. 13.  
(See Appendix, page 215)





## EINIGE UNTERSUCHUNGEN ÜBER DIE INTENSITÄTS- VERTEILUNG BEI DEN IM RADIUMHEMMET GE- BRÄUCHLICHEN DISTANZBEHANDLUNGEN

von

*Rolf M. Sievert*

In einem vorhergehenden Band dieser Zeitschrift hat LYSHOLM<sup>1</sup> unter dem Titel: »Apparatus for production of a narrow beam of rays in treatment by radium at a distance« eine von ihm konstruierte Vorrichtung (»Radiumkanone«) zur Distanzbehandlung mit grossen Radiumquantitäten beschrieben. Diese Vorrichtung hat sich als sehr zweckmässig erwiesen, und die Resultate der mit ihr vorgenommenen Behandlungen übertrafen in mehreren Fällen die mit anderen Methoden erhaltenen. Es sollen daher hier einige Messungen der von diesem Apparat ausgehenden Strahlung kurz beschrieben werden.

Um die »Radiumkanone« (Vergl. Fig. 1) bei den Behandlungen in einer gewünschten Lage festzuhalten, hat es sich als zweckmässig erwiesen, ein Zwischenstück, wie Fig. 2 zeigt, anzuwenden. *A* ist eine 2 mm starke Messingplatte, die zugleich als Filtrum dient und an den Radiumbehälter angeschraubt wird. Zwischen *A* und dem mit Gasbinde umwundenen, an der Haut anliegenden Ring *C* befindet sich ein 1½ mm dickes Messingblech *B*. Dieses hat zum Zweck, die von *A* und den inneren Begrenzungsflächen der »Kanone« ausgehende, weiche Sekundärstrahlung abzuschwächen.<sup>2</sup>

Die »Kanone« nebst dem angeschraubten Zwischenstück wurde auf einem Stativ in der Weise befestigt, dass eine Verschiebung in der gewünschten Richtung möglich war. Das Ganze wurde vor der Ionisierungskammer *I* (Fig. 1) aufgestellt. Die Kammer war mit einem, in dieser Zeitschrift<sup>3</sup> bereits beschriebenen Messinstrument verbunden. Die Ionisierungskammer war in einen Paraffinblock *P* eingebaut, und vor derselben konnten mehrere, verschieden lange

<sup>1</sup> LYSHOLM, Acta Radiologica 2, S. 516, 1923.

<sup>2</sup> SIEVERT, Acta Radiologica, 2, S. 263, 1923.

<sup>3</sup> SIEVERT, Acta Radiologica, 2, S. 156, 1923.

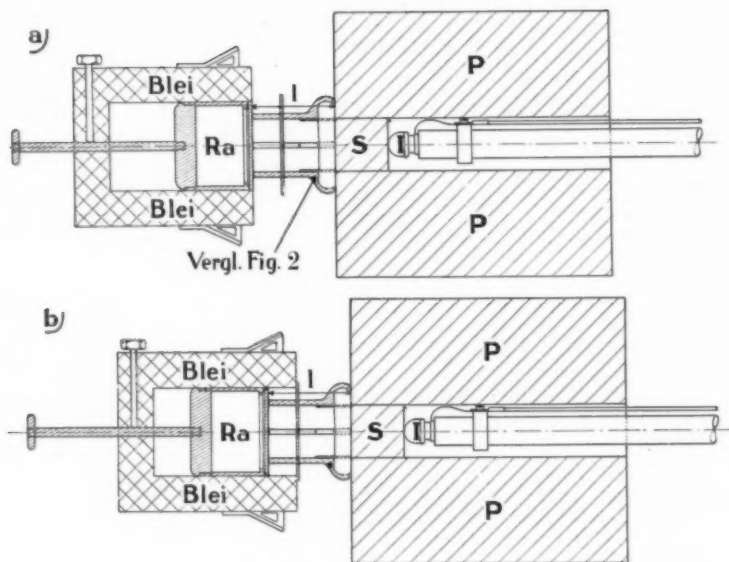


Fig. 1.

Paraffinpfpropfen ( $S$ ) eingesteckt werden. Die Wände der Kammer bestanden aus etwa 0.2 mm Aluminium-Blech und konnten, wenn gewünscht, mit einem 2 mm starken Messingmantel umgeben werden. Auf diese Weise war es möglich, die reine  $\gamma$ -Strahlung zu untersuchen, während ohne einen solchen Mantel ein beträchtlicher Teil der oben erwähnten, sekundären Strahlung (hauptsächlich  $\beta$ -Strahlen) ebenfalls zur Wirkung gelangte. Bei den Messungen befand sich das Zwischenstück sowohl in Lage a) wie in Lage b) nach Fig. 1.

Die Untersuchungen umfassten folgende Punkte:

Abblendung der  $\gamma$ -Strahlen durch den Blei-cylinder der »Kanone».

Effektivität des Sekundärfiltrums  $B$ .

Verteilung der  $\gamma$ -Strahlenintensität bei zunehmender Tiefe unter der Haut.

Die Abblendung der  $\gamma$ -Strahlen wurde durch Messen der Intensität in winkelrecht zur Achse der »Kanone» gelegten Ebenen vorgenommen, u. zw. sowohl in der Haut, wie 2 und 6 cm unter derselben. Die betr. Resultate gehen aus den Kurven in Fig. 3 a) und b), die sich auf die Fälle a) und b) in Fig. 1 beziehen, hervor.

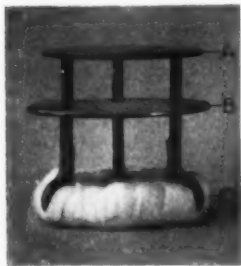
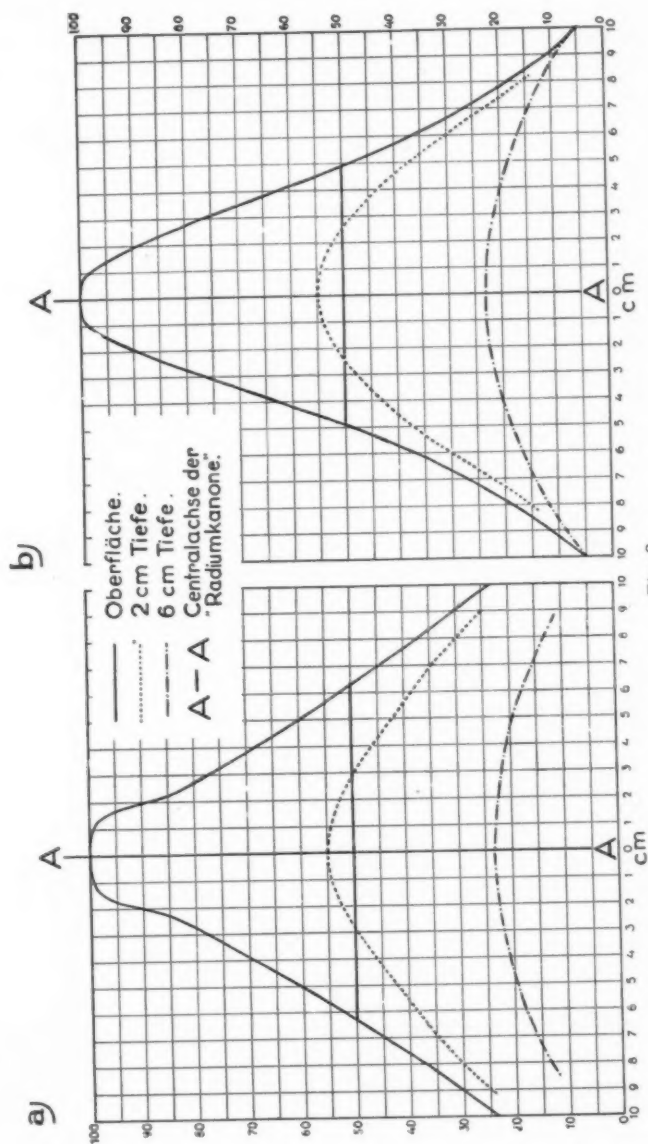


Fig. 2.



Wie vorausszusehen war, war die Abblendung im Falle b) eine wesentlich stärkere.

Die Fähigkeit des Filtrums *B*, die sekundäre, weiche Strahlung fernzuhalten, ist aus folgender Tabelle ersichtlich, indem sich deren Zahlen auf 5 cm Abstand (1 in Fig. 1) beziehen.

		Intensität bei Zwischenstück in	
		Lage a)	Lage b)
Harte + weiche Strahlung . . .	ohne <i>B</i> . . . . .	100 %	100 %
	mit <i>B</i> . . . . .	84 %	77 %
Harte Strahlung . . . . .	ohne <i>B</i> . . . . .	100 %	100 %
	mit <i>B</i> . . . . .	95 %	94 %

Da das Sekundärfiltrum höchstens 8 % der Strahlung zu absorbieren im Stande ist,<sup>1</sup> kann man leicht den Schluss ziehen, dass die von Platte *A* und deren Umgebung ausgehenden Sekundärstrahlungen durch Filtrum *B* mindestens um 75 % bei a) bzw. um 85 % bei b) herabgesetzt werden. Die Resultate deuten u. A. auch auf eine starke Sekundärstrahlung der inneren Wände des Bleicylinders hin.

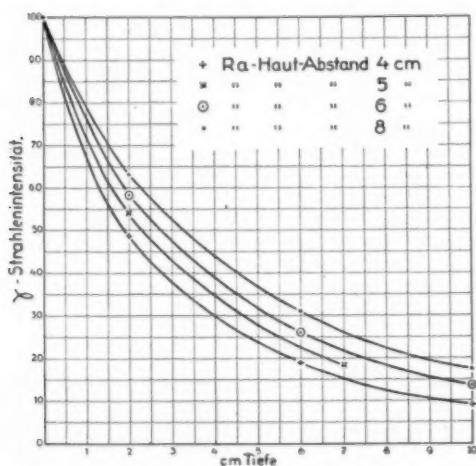


Fig. 4.

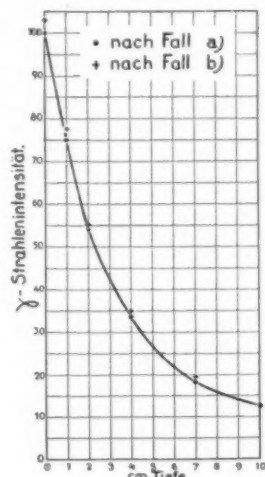


Fig. 5.

Was schliesslich die Intensitätsabnahme bei zunehmender Tiefe unter der Haut betrifft, so geht diese aus den Kurven der Fig. 4 und 5 hervor. Eine Erhöhung des Radium-Haut-Abstandes hat

<sup>1</sup> Vergl. KOHLRAUSCH. Jahrbuch der Radioaktivität und Elektronik, 15, S. 64, 1918.

selbstverständlich eine günstigere Tiefendosisverteilung zur Folge, doch werden hierbei die Behandlungszeiten bei den bei uns benutzten Radium-Quantitäten (500—1,000 mgr) zu lang. Man hat deshalb einen Abstand von 5 cm ( $l$  in Fig. 1) für den geeignetsten gefunden.

Bemerkenswert ist, dass die Tiefendosen-Kurven in den Fällen a) und b) keine grösseren Abweichungen zeigen. Es ist ferner zu beachten, dass sämtliche Kurven keine nennenswerten Veränderungen aufwiesen, sei es man benutzte die Ionisierungskammer mit, sei es ohne Mantel, eine Erscheinung, die die oben angedeutete Auffassung über die Effektivität des Sekundärfiltrums unterstützt.

Für die Oberflächen-Intensität bei verschiedenen Radium-Haut-Abständen gilt annähernd (innerhalb 5—10 %) das Quadratgesetz, jedoch unter der Voraussetzung, dass man von einem berechneten Strahlungspunkt ausgeht, dessen Lage ungefähr 1 cm oberhalb der Platte  $A$  ist. Beachtenswert ist auch, dass bei dem benutzten Abstände von 5 cm gerade durch die Sekundärstrahlung die Herabsetzung der Intensität infolge Absorption im Gewebe (Paraffin) kompensiert wird.

Mit Abnahme der Anschaffungskosten des Radiums wird die Distanzbehandlung sicher mehr und mehr Anwendung finden, da die Distanzmethode in den meisten für Radiumtherapie überhaupt geeigneten Fällen grössere Vorteile zu bieten scheint, als die Applikation direkt auf der Haut, dies hauptsächlich wegen der grossen Sicherheit in der Dosierung und der geringen Hautbeschädigungen.

### ZUSAMMENFASSUNG

Bei einem Apparat für Distanzbehandlungen ist die Intensitätsverteilung mit Hilfe einer Ionisierungsmethode untersucht worden.

Die betr. Messungen umfassen:

Abblendung der  $\gamma$ -Strahlen durch den Bleischutz des Apparates.

Effektivität eines Sekundärfiltrums.

Verteilung der  $\gamma$ -Strahlenintensität bei zunehmender Tiefe unter der Haut.

### SUMMARY

The distribution of intensity round an apparatus for distant therapy has been investigated by means of an ionisation method.

The measurements include:

The diversion of the  $\gamma$ -rays by means of a lead-protector.

The efficiency of a secondary filter.

The distribution of the  $\gamma$ -ray intensity with increasing depth under the skin.



## RÉSUMÉ

La distribution de l'intensité produite dans un appareil pour les traitements à distance a été examinée au moyen d'une méthode d'ionisation.

Les mensurations en question comprennent:

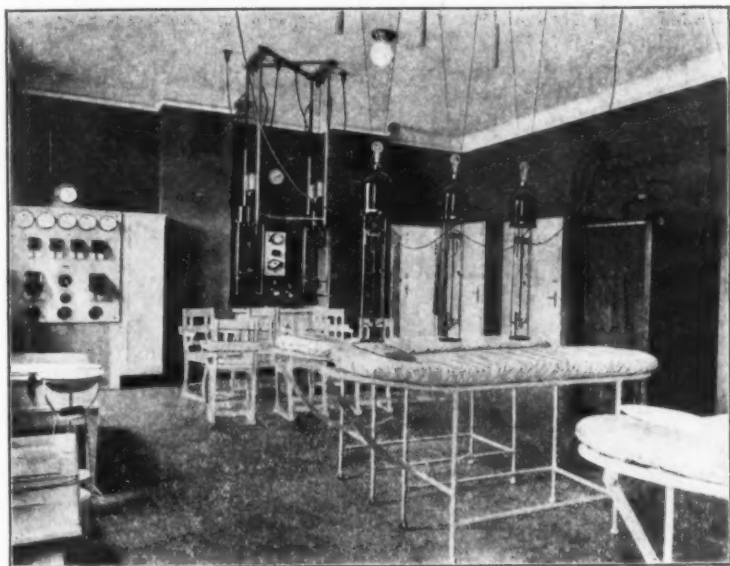
Affaiblissement des rayons  $\gamma$  par le cylindre-protecteur de plomb de l'appareil.

Efficacité du filtre secondaire  $y$  employé.

Distribution de l'intensité des rayons  $\gamma$ , quand la profondeur au-dessous de la peau s'augmente.



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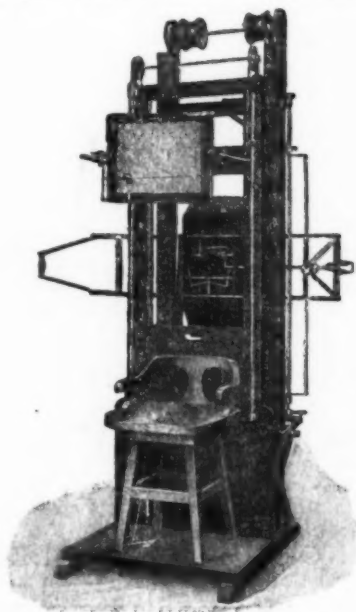
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